Part II
Protecting Air Quality

Chapter 5
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Protecting Air Quality

Airborne particulates and toxic air emissions can cause human health risks and damage the environment. Adopt controls to minimize particulate emissions. If a facility's waste management units are not addressed by requirements under the Clean Air Act, assess risks associated with toxic air emissions using the model in this guidance, and implement pollution prevention, treatment, or controls to reduce risks. For facilities that must obtain a Clean Air Act Title V permit, the permit is a good vehicle to address air emissions from waste management units.

Health effects from airborne pollutants can be minor and reversible (such as eye irritation), debilitating (such as asthma), or chronic and potentially fatal (such as cancer). Potential impacts depend on many factors, including the quantity of air pollution to which people are exposed, the duration of exposures, and the effects associated with specific pollutants. An air risk assessment takes these factors into account to project risks posed at a particular site or facility. Air releases from waste management units include particulates or wind-blown dust and toxic or hazardous contaminants. Toxic air pollutants are those pollutants known or suspected to cause cancer or other serious health effects such as reproductive effects or birth defects, or to cause adverse environmental effects.[1]

> This chapter will help you address the following questions:
>
> • Is a particular facility subject to CAA requirements?
>
> • What is an air risk assessment?
>
> • Do waste management units pose risks from volatile air emissions?
>
> • What controls will reduce particulate and volatile emissions from a facility?

We recommend that every facility implement controls to address emissions of airborne particulates. Particulates have immediate and highly visible impacts on surrounding neighborhoods. They can affect human health and may carry hazardous constituents off site as well. Generally, controls are consistent with good operating practices, and may not be too costly.

For toxic air releases from industrial solid waste management units, there are two sets of questions you need to pursue. First, what regulatory requirements under the Clean air Act (CAA) apply to the facility, and do those requirements address waste management units? The second question for facilities whose waste management units are not addressed by CAA requirements, is "are there risks from toxic air releases that should be controlled?"

[1]From "Taking Toxics Out of the Air: Progress in Setting Maximum Achievable Control Technology: Standards Under the Clean Air Act" U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, EPA451-K-98-001, February 1998.

This Guide provides two tools to help you answer these questions. First, this chapter includes an overview of the major emission control requirements under the CAA and a decision guide to evaluate which of these may apply to a facility. Each facility subject to any of these requirements must obtain a CAA Title V operating permit. The decision guide will help you to clarify some of the key facility information you need to identify applicable CAA requirements.

If your answers in the decision guide indicate that the facility is or might be subject to specific regulatory obligations, the next step is to consult with EPA, state, or local air quality program staff. Some CAA regulations are industry-specific and operation-specific within an industry, others are pollutant specific or specific to a geographic area. EPA, state, or local air quality managers can help you precisely determine applicable requirements and whether waste management units are addressed by those requirements.

You may find that waste management units are not addressed or that a specific facility clearly does not fit into any regulatory category under the CAA. It is then prudent to look beyond immediate permit requirements to assess risks associated with volatile organic compounds (VOCs) released from the unit. We recommend a two-tiered approach to this assessment, depending on the complexity and amount of site specific data you have.

Limited site-specific air assessment: The CD ROM version of this Guide contains the Industrial Waste Air Model (IWAIR). If a waste contains any of the 95 constituents included in the model, you can use this risk model to assess whether VOC emissions pose a risk that warrants additional emission controls or that could be addressed more effectively with pollution prevention or waste treatment before placement in the waste management unit.

Comprehensive Risk Assessment: This assessment relies on a comprehensive analysis of waste and site-specific data and use of models designed to assess multi-pathway exposures to airborne contaminants. There are a number of modeling tools available for this analysis. Consult closely with your air quality management agency as you proceed.

Airborne emissions are responsible for the loss of visibility between the left and right photographs of the Grand Canyon. Source: National Park Service, Air Resources Division.

I. Federal Airborne Emission Control Programs

Four major federal programs address airborne emissions that can degrade air quality. For more information about the CAA and EPA's implementation of it, see Appendix I or visit the Technology Transfer Network, EPA's premier technical web site for information transfer and sharing related to air pollution topics, at <www.epa.gov/ttn>.

If the facility is subject to any CAA requirements, the owners must obtain a permit under Title V of CAA and/or other state air permitting programs. As part of the permitting process, develop an emissions inventory for the facility. Some states have additional permitting requirements. Whether or not emissions from a waste management unit(s) will be specifically addressed through the permit process depends on a number of factors, including the type of facility and state permitting resources and priorities. It is prudent, however, where there are no applicable air permit requirements to assess whether there may be risks associated with waste management units and to address these risks.

A. National Ambient Air Quality Standards

The CAA authorizes EPA to establish emission limits to achieve National Ambient Air Quality Standards (NAAQS).[2] EPA has designated NAAQS for the following criteria pollutants: ozone, sulfur dioxide, nitrogen dioxide, lead, particulate matter (PM), and carbon monoxide. The NAAQS establish individual pollutant concentration ceilings that should be rarely exceeded in a predetermined geographical area (National Ambient Air Quality District (NAAQD)). NAAQS are not enforced directly by EPA. Instead, each state must submit a State Implementation Plan (SIP) describing how it will achieve or maintain NAAQS. Many SIPs call for airborne emission limits on industrial facilities.

If a waste emits VOCs, which can be precursors to ozone, the waste management unit could be affected by EPA's revised NAAQS for ground-level ozone.[3] EPA will phase out and replace the previous 1-hour averaging time ozone standard with a new 8-hour averaging time standard to protect over longer exposure periods. The previous 1-hour standard of 0.12 parts per million (ppm) will be replaced with a new 8-hour standard of 0.08 ppm. Phasing in the new standard will take place in several ways. States or areas of states that have not been able to comply with current 0.12 ppm 1-hour standard will not be subject to more stringent requirements until they meet the 1-hour standard for three consecutive years. States and areas already achieving the 1-hour standard may be eligible to participate in regional emission control strategies or submit early SIPs to address the new 8-hour standard. Consult with your state to determine whether efforts to comply with the ozone NAAQS involve VOC emission limits that apply to a specific facility.

B. New Source Performance Standards

New Source Performance Standards (NSPSs) may apply to any building, structure, facility, or installation which emits or may emit an air pollutant for which a NAAQS (criteria pollutants) exists. For industry categories, NSPSs establish national technology-based emission limits for criteria air pollutants,[7] such as particulate matter (PM), or for their precursors, such as VOCs. States have primary responsibility for assuring that the NSPSs are followed. These standards are distinct from

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[2] 42 U.S.C. § 7409

[3] 62 *FR* 38856 (July 18, 1997)

[7]

NAAQS because they establish direct national emission limits for specified sources, while NAAQS establish air quality targets that states meet using a variety of measures that include emission limits. Table 1 lists industries for which NSPSs have been established and locations of the NSPSs in the Code of Federal Regulations. Check to see if any of the 74 New Source Performance Standards (NSPSs)[4] apply to the facility.[5] Any facility subject to a NSPS must obtain a Title V operating permit (see section D below.).

C. National Emission Standards for Hazardous Air Pollutants

Waste streams that are not hazardous waste under RCRA may generate air pollutants that have a hazardous air pollutant (HAP) regulatory status under the CAA. Section 112 of the CAA Amendments of 1990[6] requires EPA to establish national standards to reduce HAP emissions. Section 112(b) contains a list of 188 HAPs (see Table 2) to be regulated by National Emission Standards for Hazardous Air Pollutants (NESHAPs) or Maximum Achievable Control Technology (MACT) standards, that are generally set on an industry-by-industry basis.

MACT standards apply only to major sources. A major source is defined as any stationary source or group of stationary sources that (1) is located within a contiguous area and under common control, and (2) emits or has the potential to emit at least 10 tons per year (tpy) of any single HAP or at least 25 tpy of any combination of HAPs. All fugitive emissions, including emissions from waste management units, are to be taken into account in determining whether a stationary source is a major source. Each MACT standard limits specific operations, processes, and/or wastes that are covered. Some MACT standards specifically cover waste management units, others do not. If a facility is covered by a MACT standard, it must be permitted under Title V (see below).

EPA has identified approximately 170 industrial categories and subcategories that are or will be subject to MACT standards. The CAA calls for EPA to promulgate the standards in four phases. Standards already promulgated in the first two phases are listed in Table 3. The schedule for the last two phases extends through 2000 (see Appendix I).

CAA also requires EPA to assess the risk to public health remaining after the implementation of NESHAPs and MACT standards. EPA must determine if more stringent standards are necessary to protect public health with an ample margin of safety. As a first step in this process the CAA requires EPA to submit a Report to Congress on its methods for making the health risks from residual emissions determination. A draft of this report was submitted to Congress on April 14, 1998, and the final version is due February 1, 1999. If significant residual risk exists after application of a MACT, EPA must promulgate health-based standards for that source category to further reduce HAP emissions. EPA must set residual risk standards within 9 years after promulgation of each NESHAP in the first phase group and within 8 years for all other phases of source categories.

D. Title V Operating Permits

For many facilities, the new federal operating permit program established under Title V of the CAA will cover all sources of airborne emissions. It requires a permit for any facility

[4]40 CFR Part 60

[4]While NSPSs apply to new facilities, EPA also established emissions guidelines for existing facilities.

[6]42 U.S.C. § 7412.

Table 1
Industries for Which NSPSs Have Been Established

For electronic versions of the 40 CFR Part 60 subparts referenced below, visit **<earth1.epa.gov/epacfr40/chapt-I.info/subch-C/40P0060/>**. Be sure to check the *Federal Register* for updates that may have been published after this guidance.

Facility	40 CFR Part 60 Subpart	Facility	40 CFR Part 60 Subpart
Ammonium Sulfate Manufacture	PP	Onshore Natural Gas Processing: SO_2 Emissions	LLL
Asphalt Processing & Asphalt Roofing Manufacture	UU	Petroleum Dry Cleaners, Rated Capacity ≥ 84 Lb	JJJ
Auto/ld Truck Surface Coating Operations	MM	Petroleum Refineries	J
Basic Oxygen Process Furnaces after 6/11/73	N	Petroleum Refinery Wastewater Systems	QQQ
Beverage Can Surface Coating Industry	WW	Phosphate Fertilizer-Wet Process Phosphoric Acid	T
Bulk Gasoline Terminals	XX	Phosphate Fertilizer-Superphosphoric Acid	U
Calciners and Dryers in Mineral Industry	UUU	Phosphate Fertilizer-Diammonium Phosphate	V
Coal Preparation Plants	Y	Phosphate Fertilizer-Triple Superphosphate	W
Electric Utility Steam Generating Units after 9/18/78	DA	Phosphate Fertilizers: GTSP Storage Facilities	X
Equipment Leaks of VOC in Petroleum Refineries	GGG	Phosphate Rock Plants	NN
Equipment Leaks of VOC in SOCMI	VV	Polymer Manufacturing Industry	DDD
Ferroalloy Production Facilities	Z	Polymeric Coating of Supporting Substrates Fac.	VVV
Flexible Vinyl & Urethane Coating & Printing	FFF	Portland Cement Plants	F
Fossil-fuel Fired Steam Generators after 8/17/71	D	Pressure Sensitive Tape & Label Surface Coating	RR
Glass Manufacturing Plants	CC	Primary Aluminum Reduction Plants	S
Grain Elevators	DD	Primary Copper Smelters	P
Graphic Arts: Publication Rotogravure Printing	QQ	Primary Lead Smelters	R
Hot Mix Asphalt Facilities	I	Primary Zinc Smelters	Q
Incinerators	E	Rubber Tire Manufacturing Industry	BBB
Industrial Surface Coating, Plastic Parts	TTT	Secondary Brass and Bronze Production Plants	M
Industrial Surface Coating-Large Appliances	SS	Secondary Lead Smelters	L
Industrial-Commercial-Institutional Steam Gen. Unit	DB	Sewage Treatment Plants	O
Kraft Pulp Mills	BB	Small Indust./Comm./Institut. Steam Generating Units	DC
Large Municipal Waste Combustors after 9/20/94	EB	SOCMI - Air Oxidation Processes	III
Lead-Acid Battery Manufacturing Plants	KK	SOCMI - Distillation Operations	NNN
Lime Manufacturing	HH	SOCMI Reactors	RRR
Magnetic Tape Coating Facilities	SSS	SOCMI Wastewater	YYY
Medical Waste Incinerators (MWI) after 6/20/96	EC	Stationary Gas Turbines	GG
Metal Coil Surface Coating	TT	Steel Plants: Elec. Arc Furnaces after 08/17/83	AAA
Metallic Mineral Processing Plants	LL	Steel Plants: Electric Arc Furnaces	AA
Municipal Solid Waste Landfills after 5/30/91	WWW	Storage Vessels for Petroleum Liquids	K
Municipal Waste Combustors (MWC)	EA	Storage Vessels for Petroleum Liquids	KA
New Residential Wood Heaters	AAA	Sulfuric Acid Plants	H
Nitric Acid Plants	G	Surface Coating of Metal Furniture	EE
Nonmetallic Mineral Processing Plants	OOO	Synthetic Fiber Production Facilities	HHH
Onshore Natural Gas Processing Plants, VOC Leaks	KKK	Volatile Storage Vessel (Incl. Petroleum) after 7/23/84	KB
		Wool Fiberglass Insulation Manufacturing Plants	PPP

Table 2
HAPs Defined in Section 112 of the CAA Amendments of 1990

CAS#	CHEMICAL NAME
75070	Acetaldehyde
60355	Acetamide
75058	Acetonitrile
98862	Acetophenone
53963	2-Acetylaminofluorene
107028	Acrolein
79061	Acrylamide
79107	Acrylic acid
107131	Acrylonitrile
107051	Allyl chloride
92671	4-Aminobiphenyl
62533	Aniline
90040	o-Anisidine
1332214	Asbestos
71432	Benzene (including benzene from gasoline)
92875	Benzidine
98077	Benzotrichloride
100447	Benzyl chloride
92524	Biphenyl
117817	Bis(2-ethylhexyl) phthalate (DEHP)
542881	Bis(chloromethyl)ether
75252	Bromoform
106990	1,3-Butadiene
156627	Calcium cyanamide
133062	Captan
63252	Carbaryl
75150	Carbon disulfide
56235	Carbon tetrachloride
463581	Carbonyl sulfide
120809	Catechol
133904	Chloramben
57749	Chlordane
7782505	Chlorine
79118	Chloroacetic acid
532274	2-Chloroacetophenone
108907	Chlorobenzene
510156	Chlorobenzilate
67663	Chloroform
107302	Chloromethyl methyl ether
126998	Chloroprene
1319773	Cresols/Cresylic acid (isomers and mixture)
95487	o-Cresol
108394	m-Cresol
106445	p-Cresol
98828	Cumene
94757	2,4-D, salts and esters
3547044	DDE
334883	Diazomethane
132649	Dibenzofurans
96128	1,2-Dibromo-3-chloropropane
84742	Dibutylphthalate
106467	1,4-Dichlorobenzene(p)
91941	3,3-Dichlorobenzidene
111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)
542756	1,3-Dichloropropene
62737	Dichlorvos
111422	Diethanolamine
121697	N,N-Diethyl aniline (N,N-Dimethylaniline)
64675	Diethyl sulfate
119904	3,3-Dimethoxybenzidine
60117	Dimethyl aminoazobenzene
119937	3,3'-Dimethyl benzidine
79447	Dimethyl carbamoyl chloride
68122	Dimethyl formamide
57147	1,1-Dimethyl hydrazine
131113	Dimethyl phthalate
77781	Dimethyl sulfate
534521	4,6-Dinitro-o-cresol, and salts
51285	2,4-Dinitrophenol
121142	2,4-Dinitrotoluene
123911	1,4-Dioxane (1,4-Diethyleneoxide)
122667	1,2-Diphenylhydrazine
106898	Epichlorohydrin (l-Chloro-2,3-epoxypropane)
106887	1,2-Epoxybutane
140885	Ethyl acrylate
100414	Ethyl benzene
51796	Ethyl carbamate (Urethane)
75003	Ethyl chloride (Chloroethane)
106934	Ethylene dibromide (Dibromoethane)
107062	Ethylene dichloride (1,2-Dichloroethane)
107211	Ethylene glycol
151564	Ethylene imine (Aziridine)
75218	Ethylene oxide
96457	Ethylene thiourea
75343	Ethylidene dichloride (1,1-Dichloroethane)
50000	Formaldehyde
76448	Heptachlor
118741	Hexachlorobenzene
87683	Hexachlorobutadiene
77474	Hexachlorocyclopentadiene
67721	Hexachloroethane
822060	Hexamethylene-1,6-diisocyanate
680319	Hexamethylphosphoramide
110543	Hexane
302012	Hydrazine
7647010	Hydrochloric acid
7664393	Hydrogen fluoride (Hydrofluoric acid)
123319	Hydroquinone
78591	Isophorone
58899	Lindane (all isomers)
108316	Maleic anhydride
67561	Methanol
72435	Methoxychlor
74839	Methyl bromide (Bromomethane)
74873	Methyl chloride (Chloromethane)
71556	Methyl chloroform (1,1,1-Trichloroethane)
78933	Methyl ethyl ketone (2-Butanone)
60344	Methyl hydrazine
74884	Methyl iodide (Iodomethane)
108101	Methyl isobutyl ketone (Hexone)
624839	Methyl isocyanate
80626	Methyl methacrylate
1634044	Methyl tert butyl ether
101144	4,4-Methylene bis(2 -chloroaniline)
75092	Methylene chloride (Dichloromethane)
101688	Methylene diphenyl diisocyanate (MDI)
101779	4,4'-Methylenedianiline
91203	Naphthalene
98953	Nitrobenzene
92933	4-Nitrobiphenyl
100027	4-Nitrophenol
79469	2-Nitropropane
684935	N-Nitroso-N-methylurea
62759	N-Nitrosodimethylamine
59892	N-Nitrosomorpholine
56382	Parathion
82688	Pentachloronitrobenzene (Quintobenzene)
87865	Pentachlorophenol

Table 2 (continued)
HAPs Defined in Section 112 of the CAA Amendments of 1990

CAS#	CHEMICAL NAME	CAS#	CHEMICAL NAME	CAS#	CHEMICAL NAME
108952	Phenol	79345	1,1,2,2-Tetrachloroethane	1330207	Xylenes (isomers and mixture)
106503	p-Phenylenediamine	127184	Tetrachloroethylene (Perchloroethylene)	95476	o-Xylenes
75445	Phosgene	7550450	Titanium tetrachloride	108383	m-Xylenes
7803512	Phosphine	108883	Toluene	106423	p-Xylenes
7723140	Phosphorus	95807	2,4-Toluene diamine	[none]	Antimony Compounds
85449	Phthalic anhydride	584849	2,4-Toluene diisocyanate	[none]	Arsenic Compounds (inorganic including arsine)
1336363	Polychlorinated biphenyls (Aroclors)	95534	o-Toluidine	[none]	Beryllium Compounds
1120714	1,3-Propane sultone	8001352	Toxaphene (chlorinated camphene)	[none]	Cadmium Compounds
57578	beta-Propiolactone	20821	1,2,4-Trichlorobenzene	[none]	Chromium Compounds
123386	Propionaldehyde	79005	1,1,2-Trichloroethane	[none]	Cobalt Compounds
114261	Propoxur (Baygon)	79016	Trichloroethylene	[none]	Coke Oven Emissions
78875	Propylene dichloride (1,2-Dichloropropane)	95954	2,4,5-Trichlorophenol	[none]	Cyanide Compounds[a]
75569	Propylene oxide	88062	2,4,6-Trichlorophenol	[none]	Glycol ethers[b]
75558	1,2-Propylenimine (2-Methyl aziridine)	121448	Triethylamine	[none]	Lead Compounds
91225	Quinoline	582098	Trifluralin	[none]	Manganese Compounds
106514	Quinone	540841	2,2,4-Trimethylpentane	[none]	Mercury Compounds
100425	Styrene	108054	Vinyl acetate	[none]	Fine mineral fibers[c]
96093	Styrene oxide	593602	Vinyl bromide	[none]	Nickel Compounds
1746016	2,3,7,8-Tetrachlorodi-benzo-p-dioxin	75014	Vinyl chloride	[none]	Polycylic Organic Matter[d]
		75354	Vinylidene chloride (1,1-Dichloroethylene)	[none]	Radionuclides (incl. radon)[e]
				[none]	Selenium Compounds

NOTE: For all listings above which contain the word "compounds'" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical's infrastructure.

[a]X'CN where X = H' or any other group where a formal dissociation may occur. For example KCN or Ca(CN)2.

[b]Includes mono- and di-ethers of ethylene glycol, diethylene glycol, and triethylene glycol R-(OCH2CH2)n-OR' where n = 1, 2, or 3, R = alkyl or aryl groups, and R' = R, H, or groups which, when removed, yield glycol ethers with the structure: R-(OCH2CH)n-OH. Polymers are excluded from the glycol category.

[c]Includes mineral fiber emissions from facilities manufacturing or processing glass, rock, or slag fibers (or other mineral derived fibers) of average diameter 1 micrometer or less.

[d]Includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 °C.

[e]A type of atom which spontaneously undergoes radioactive decay.

emitting or having the potential to emit more than 100 tpy of any air pollutants.[7] Permits are also required for all sources subject to MACT or NSPS standards. All airborne emission requirements that apply to an industrial facility, including emission limitations as well as operational, monitoring, and reporting requirements, will be incorporated in its operating permit. A Title V permit provides a single tool to address all emissions from facilities subject to CAA requirements.

Under the new program, operating permits that meet federal requirements will generally be issued by state agencies. In developing individual permits, states can determine whether to explicitly apply emission limitations and controls to waste management units. See section F (A Decision Guide to Applicable CAA Requirements), and consult with federal, state, and local air program staff to determine if your waste management unit is subject to airborne emission limits and

[7]Under CAA Section 302(g), "air pollutant" is defined as any pollutant agent or combination of agents, including any physical, chemical, biological, or radioactive substance or matter which is emitted into or otherwise enters the ambient air.

Table 3
Source Categories With MACT Standards*

Source Category	Federal Register Page
Non-Ferrous Metals Processing	
Secondary Lead Smelting	60 FR 32587 (6/23/95)
Primary Aluminum Reduction	62 FR 52383 (10/7/97)
Primary Copper Smelting	63 FR 19582 (4/20/98)(P)
Primary Lead Smelting	63 FR 19200 (4/17/98)(P)
Ferrous Metals Processing	
Coke Ovens	58 FR 57898 (10/27/93)
Steel Pickling HCI Process	62 FR 49051 (9/18/97)(P)
Mineral Products Processing	
Mineral Wool Production	62 FR 25369 (5/8/97) (P)
Portland Cement Manufacturing	63 FR 14181 (3/24/98)(P)
Wool Fiberglass Manufacturing	62 FR 15227 (3/21/97) (P)
Petroleum and Natural Gas Production and Refining	
Oil & Natural Gas Production	63 FR 06288 (2/6/98)(P)
Natural Gas Transmission and Storage	63 FR 06288 (2/6/98)(P)
Petroleum Refineries	60 FR 43244 (8/18/95)
Liquids Distribution	
Gasoline Distribution	59 FR 64303 (12/14/95)
Marine Vessel Loading	60 FR 48399 (9/19/95)
Surface Coating Processes	
Aerospace Industries	60 FR 45948 (9/1/95)
Magnetic Tapes	59 FR 64580 (12/15/94)
Printing/Publishing	61 FR 27132 (5/30/96)
Shipbuilding and Repair	60 FR 64330 (12/15/95)
Wood Furniture	60 FR 62930 (12/7/95)
Waste Treatment and Disposal	
Off-Site Waste and Recovery Operations	61 FR 34141 (7/1/96)
Agricultural Chemicals Production	
Agricultural Chemicals Production	62 FR 60565 (11/10/97) (P)
Pharmaceutical Production Processes	
Pharmaceutical Production	62 FR 15753 (4/2/97) (P)
Polymers and Resins Production	
Acrylonitrile-Butadiene-Styrene	61 FR 48207 (9/12/96)
Butyl Rubber	61 FR 46905 (9/5/96)
Epichlorohydrin Elastomers	61 FR 46905 (9/5/96)
Epoxy Resins Production	60 FR 12670 (3/8/95)
Ethylene-Propylene Rubber	61 FR 46905 (9/5/96)
Flexible Polyurethane Foam	61 FR 68405 (12/27/96) (P)
Hypalon™	61 FR 46905 (9/5/96)
Methyl Methacrylate-Acrylonitrile-Butadiene-Styrene	61 FR 48207 (9/12/96)
Methyl Methacrylate-Butadiene-Styrene Terpolymers	61 FR 48207 (9/12/96)
Neoprene	61 FR 46905 (9/5/96)
Nitrile Butadiene Rubber	61 FR 46905 (9/5/96)
Nitrile Resins Production	61 FR 48207 (9/12/96)
Non-Nylon Polyamides	60 FR 12670 (3/8/95)
Polybutadiene Rubber	61 FR 46905 (9/5/96)
Polyether Polyols	62 FR 46803 (9/4/97) (P)
Polyethylene Terephthalate	61 FR 48207 (9/12/96)
Polystyrene	61 FR 48207 (9/12/96)
Polysulfide Rubber	61 FR 46905 (9/5/96)
Styrene-Acrylonitrile	61 FR 48207 (9/12/96)
Styrene-Butadiene Rubber, Latex	61 FR 46905 (9/5/96)
Production of Inorganic Chemicals	
Phosphate Fertilizers Production	61 FR 68429 (12/27/96) (P)
Phosphoric Acid Manufacturing	61 FR 68429 (12/27/96) (P)
Production of Organic Chemicals	
Synthetic Organic Chemicals Manufacturing	59 FR 19402 (4/22/94), 62 FR 2721 (1/17/97)
Miscellaneous Processes	
Chromic Acid Anodizing	60 FR 4947 (1/25/95)
Commercial Dry Cleaning (Perchloroethylene)	58 FR 49353 (9/22/93)
Commercial Sterilization Facilities	59 FR 62585 (12/6/94)
Decorative Chromium Electroplating	60 FR 4948 (1/25/95)
Halogenated Solvent Cleaners	59 FR 61801 (12/2/94)
Hard Chromium Electroplating	60 FR 4948 (1/25/95)
Industrial Cleaning (Perchloroethylene)	58 FR 49353 (9/22/93)
Industrial Dry Cleaning (Perchloroethylene)	58 FR 49353 (9/22/93)
Industrial Process Cooling Towers	59 FR 46339 (9/8/94)
Pulp and Paper Production	63 FR 18503 (4/15/98)
Tetrahydrobenzaldehyde Production	62 FR 44614 (8/22/97) (P)

* This table contains final rules and proposed rules (P) promulgated as of May 1998. It does not identify corrections or clarifications to rules.

controls under CAA regulations. (See Appendix II for a listing of EPA regional and state air pollution control agency contacts.)

E. Federal Airborne Emission Regulations for Solid Waste Management Activities

While EPA has not established airborne emission regulations for nonhazardous industrial waste management units under RCRA, standards developed for hazardous waste management units and municipal solid waste landfills (MSWLFs) may serve as a guide in evaluating the need for controls at specific units.

1. Hazardous Waste Management Unit Airborne Emission Regulations

Under Section 3004(n) of RCRA, EPA established standards for monitoring and control of airborne emissions from hazardous waste treatment, storage, and disposal facilities. Subparts AA, BB, and CC of 40 CFR Part 265 address VOC releases from process vents, equipment leaks, tanks, surface impoundments, and containers. (See Appendix III for a more detailed discussion of Subparts AA, BB, and CC.) Subpart CC establishes requirements for hazardous waste surface impoundments containing waste with volatile organic content greater than 500 ppm by weight. It exempts units managing wastes that have been treated to reduce concentrations of organics. For non-exempt surface impoundments, Subpart CC requires the use of covers and closed vent systems that reduce VOC emissions by 95 percent. Closed vent systems include vapor recovery units, flares, and other combustion units.

2. Municipal Solid Waste Landfill Airborne Emission Regulations

On March 12, 1996, EPA promulgated airborne emission regulations for new and existing MSWLFs.[8] These regulations apply to all new MSWLFs constructed on or after May 30, 1991 and to existing landfills with total design capacities of 2.5 million megagrams per year (Mg/yr) (approximately 2.75 million tpy) that have accepted waste on or after November 8, 1987. In addition to methane, MSWLFs potentially emit criteria pollutants and HAPs in the gases generated during waste decomposition, as well as in combustion of the gases in control devices, and from other sources, such as dust from vehicle traffic and emissions from leachate treatment facilities or maintenance shops. Under the regulations, any affected MSWLF that emits more than 50 Mg/yr (55 tpy) of nonmethane organic compounds (NMOC) is required to install controls.

Best demonstrated technology requirements for both new and existing municipal landfills prescribe installation of a well-designed and well-operated gas collection system and a control device. The collection system should be designed to allow expansion for new cells that require controls. The control device (presumed to be a combustor) must demonstrate either an NMOC reduction of 98 percent by weight in the collected gas or an outlet NMOC concentration of no more than 20 parts per million by volume (ppmv).

3. Off-Site Waste and Recovery Operations NESHAP

On July 1, 1996, EPA established standards for off-site waste and recovery operations (OSWRO) that emit HAPs.[9] To be covered by OSWRO, a facility must emit or have the potential to emit at least 10 tpy of any single HAP or at least 25 tpy or any combination of HAPs. It must receive waste, used oil, or used

[8] 61 *FR* 9905

[9] 61 FR 34139

solvents from off-site that contain one or more HAPs.[10] In addition, the facility must operate one of the following: a hazardous waste treatment, storage, or disposal facility; RCRA-exempt hazardous wastewater treatment operation, nonhazardous wastewater treatment facility other than a publicly owned treatment facility; RCRA-exempt hazardous waste recycling or reprocessing operation, used solvent recovery operation, or used oil recovery operation.

OSWRO contains MACT standards to reduce HAP emissions from tanks, surface impoundments, containers, oil-water separators, individual drain systems, other material conveyance systems, process vents, and equipment leaks. For example, OSWRO establishes two levels of air emission controls for tanks depending on tank design capacity and the maximum organic HAP vapor pressure of the off-site material in the tank. For process vents, control devices must achieve a minimum of 95 percent organic HAP emission control. To control HAP emissions from equipment leaks, the facility must implement leak detection and repair work practices and equipment modifications for those equipment components containing or contacting off-site waste having a total organic HAP concentration greater than 5 percent by weight.

F. A Decision Guide to Applicable CAA Requirements

The following series of questions is designed to help you identify CAA requirements that may apply to a facility. This will not give you definitive answers, but can provide a useful starting point for consultation with federal, state, or local permitting authorities to determine which requirements apply to a specific facility and whether such requirements address waste management units at the facility. If a facility is clearly not subject to CAA requirements, we recommend that you assess potential risks from VOC emissions at a waste management unit using the IWAIR or a site-specific risk assessment.

The following steps provide a walk through of this evaluation process:

1. Determine emission from the unit:

a) Determine VOC's present in the waste (waste characterization). Then assume all the VOC's are emitted from the unit; or

b) Estimate emissions using an emissions model. This also requires waste characterization. The CHEMDAT8 model is a logical model for these types of waste units. You can use the EPA version on the Internet or the one contained in the modeling tool for this guidance; or

c) Measure emissions from the unit. This is the most resource intensive alternative.

2. Is the waste management unit part of an industrial facility which is subject to a CAA Title V operating permit?

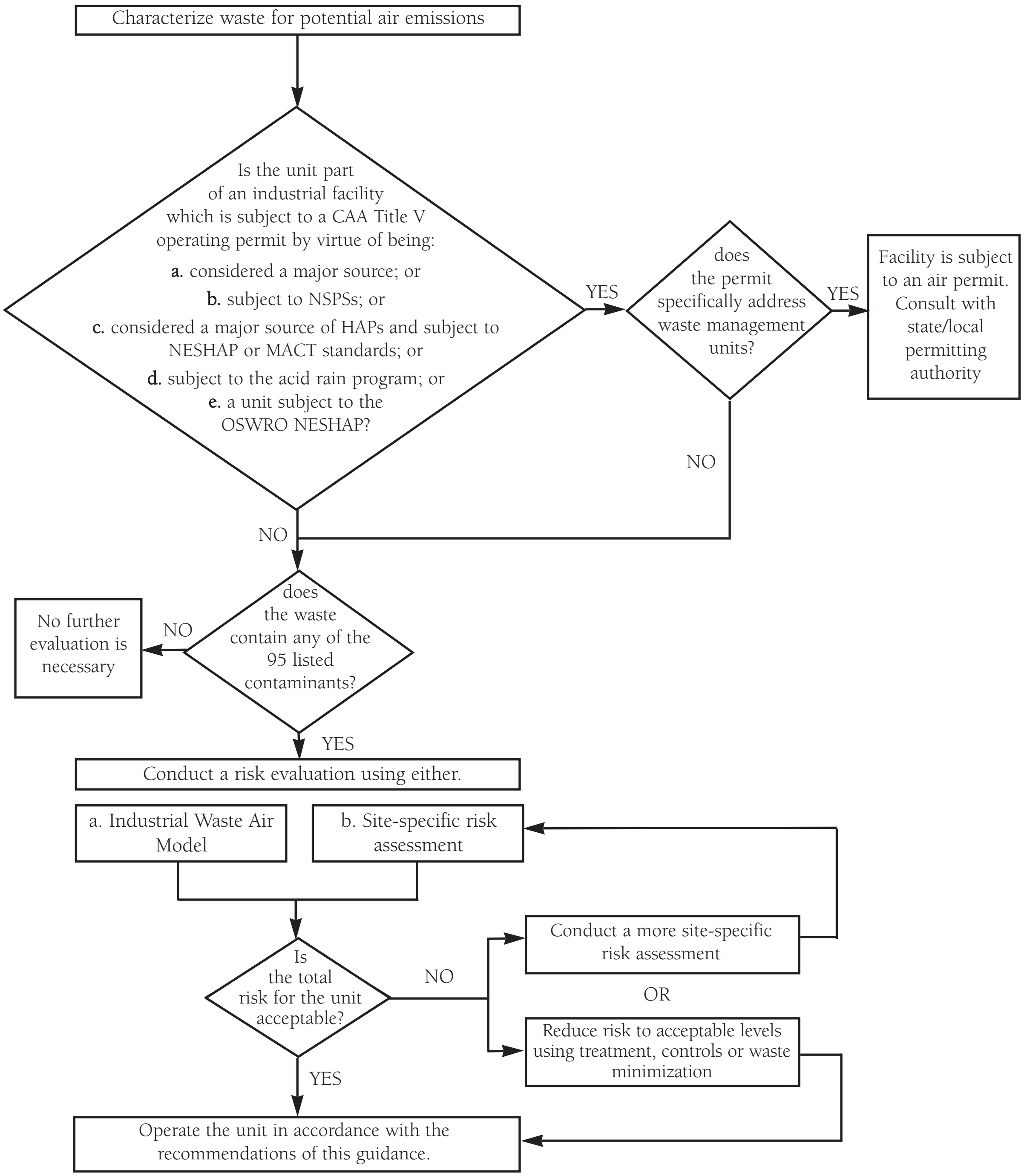
A facility is subject to a Title V operating permit if it is considered a major source of air pollutants, or is subject to a NSPS, NESHAP, or Title IV acid rain provision.[11] As part of the permitting process, the facility should develop an emissions inventory. Some states have additional permitting requirements. If a facility is subject to a Title V operating permit, all airborne emission requirements that apply to an industrial facility, including emission limitations as well as operational, monitoring, and reporting requirements, will be incorporated in its operating permit. Consult with appropriate federal, state, and local air program staff to determine whether your waste management unit is subject to air emission limits and controls.[12]

[10]OSWRO identified aproximately 10 HAPs to be covered, This HAP list is a subject of the CAA Section 112 list

[11]EPA can designate additional source categories subject to Title V operating permit requirements.

[12]Implementation of air emission controls may generate new residual waste. Ensure that these wastes are managed appropriately, in compliance with state requirements and consistent with this guidance.

Figure 1. Evaluating VOC Emission Risk



If you answer yes to any of the questions in items a. through e. below, the facility is subject to a Title V operating permit. Consult with the appropriate federal, state, and/or local permitting authority.

Whether or not emissions from waste management unit(s) will be specifically addressed through the permit process depends on a number of factors, including the type of facility and CAA requirements and state permitting resources and priorities. It is prudent, however, to look where there are not applicable air permit requirements, to assess whether there may be risks associated with waste management units and to address these potential risks.

If you answer no to all the questions below, continue to Step 3.

a. Is the facility considered a major source?

If the facility meets any of the following three definitions, it is considered a major source (under 40 CFR § 70.2) and subject to Title V operating permit requirements.

1. Any **stationary source** or group of stationary sources that emits or has the potential to emit at least 100 tpy of any **air pollutant**.

2. Any stationary source or group of stationary sources that emits or has the potential to emit at least 10 tpy of any single HAP or at least 25 tpy of any combination of HAPs.

Stationary source is defined as any buidling, structure, facility, or installation which emits or may emit any air pollutant that is located within a contiguous area and under common control.

An **air pollutant** is defined as any air pollutant agent or combination of agents, including a physical, chemical, biological, radioactive substance or matter which is emitted into or otherwise enters the ambient air

3. A stationary source or group of stationary sources subject to the nonattainment area provisions of CAA Title I that emits, or has the potential to emit, above the threshold values for its nonattainment area category. The nonattainment area category and the source's emission levels for VOCs and NO_x, particulate matter (PM-10), and carbon monoxide (CO) determine whether the stationary source meets the definition of a "major source." For nonattainment areas, stationary sources are considered "major sources" if they emit or have the potential to emit at least the levels found in Table 4.

If yes, the facility is subject to a Title V

Table 4.
Major Source Determination in Nonattainment Areas

Nonattainment Area Category[13]	VOCs or NOx	PM-10	CO
Marginal or Moderate	100 tpy	100 tpy	100 tpy
Serious	50 tpy	70 tpy	50 tpy
Severe	25 tpy	—	—
Extreme	10 tpy	—	—

[13]The nonattainment categories are based upon the severity of the area's pollution problems. The five categories for VOCs and NOx range from Moderate to Extreme. Moderate areas are the closest to meeting the attainment standard, and require the least amount of action. Nonattainment areas with more serious air quality problems must implement various control measures. The worse the air quality, the more controls areas will have to implement. PM-10 and CO have only two categories, Moderate and Serious.

operating permit. Consult with the appropriate federal, state, and/or local permitting authority.

If no, continue to determine whether the facility is subject to a Title V operating permit.

b. Is the facility subject to NSPSs?

Any stationary source subject to a standard of performance under 40 CFR Part 60 is subject to NSPS. (A list of NSPSs can be found in Table 1.)

If yes, the facility is subject to a Title V operating permit. Consult with the appropriate federal, state, and/or local permitting authority.

If no, continue to determine if the facility is subject to a Title V operating permit.

c. Is the facility a major source of HAPs as defined by Section 112 of CAA and subject to a NESHAP or MACT standard?

Under Title V of CAA, an operating permit is required for all facilities subject to a MACT standard. NESHAPs or MACT standards are national standards to reduce HAP emissions. Each MACT standard specifies particular operations, processes, and/or wastes that are covered. EPA has identified approximately 170 source categories and subcategories that are or will be subject to MACT standards. (Table 3 above lists the source categories for which EPA has promulgated MACT standards during the first two phases of MACT standard promulgation.) To be subject to a MACT standard, you must be a **major source** or an **area source** (see sidebar for definitions).

If yes, the facility should be permitted under CAA Title V. Consult with the appropriate federal, state, and/or local permitting authority.

If no, continue to determine if the facility is subject to a Title V operating permit.

> A **major source** is defined as any stationary source or group of stationary sources that emits or has the potential to emit at least 10 tpy of any single hazardous air pollutant (HAP) or at least 25 tpy of any combination of **HAPs**.
>
> An **area source** is any stationary source which is not a major source but which may be subject to controls. Area sources represent a collection of facilities and emission points for a specific geographic area. Most area sources are small, but the collective volume of large numbers of facilities can be a concern in densely developed areas, such as urban neighborhoods and industrial areas. Examples of areas sources subject to MACT standards include chromic acid anodizing, commercial sterilization facilities, decorative chromium electroplating, hard chromium electroplating, secondary lead smelting, and halogenated solvent cleaners.
>
> **HAPs** are any of the 188 pollutants listed in Section 112(b) of CAA. (Table 2 above identifies the 188 HAPs.)

d. Is the facility subject to the acid rain program under Title IV of CAA?

If the facility, such as a fossil-fuel fired power plant, is subject to emission reduction requirements or limitations under the acid rain program, it is subject to a Title V operating permit (40 CFR § 72.6). The acid rain program focuses on the reduction of annual sulfur dioxide and nitrogen oxides emissions.

If yes, the facility is subject to CAA Title V permitting. Consult with the appropriate federal, state, and/or local permitting authority.

When you consult with the appropriate permitting authority, be sure to clarify whether waste management units at the facility are addressed by the requirements. If waste management units will not be addressed through the permit process, we recommend that you evaluate VOC emission risks.

If no, continue to determine if the facility is subject to a Title V operating permit.

e. Is the waste management unit subject to the OSWRO NESHAP?

This is just an example of the types of questions you will need to answer to determine whether a NESHAP or MACT standard covers your facility.

To be covered by the OSWRO standards, your facility must meet all these conditions:

1. Be identified as a **major source** of HAP emissions

2. Receive **waste, used oil,** or **used solvents** from off site that contain one or more HAPs.[14]

3. Operate one of the following six types of waste management or recovery operations (see 40 CFR § 63.680):

- Hazardous waste treatment, storage, or disposal facility;
- RCRA-exempt hazardous wastewater treatment operation;
- Nonhazardous wastewater treatment facility other than a publicly owned treatment facility;
- RCRA-exempt hazardous waste recycling or reprocessing operation;
- Used solvent recovery operations; or
- Used oil recovery operations.

If yes, the unit should be covered by the OSWRO standards and Title V permitting. Consult with the appropriate federal, state, and/or local permitting authority.

If no, continue to Step 3. The next series of questions will help you consider options for conducting an air risk evaluation.

3. Conduct a risk evaluation using one of the following options:

a. Use IWAIR included in this guidance if your unit contains any of the 95 contaminants that are covered in the model.

b. Initiate a site-specific risk assessment for individual units. (For surface impoundments, a methodology is set forth in *Preferred and Alternative Methods for Estimating Air Emissions from Wastewater Collection and Treatment,* Volume II: Chapter 5, Emission Inventory Improvement Program, March 1997.) Total all target constituents from all applicable units and consider emissions from other sources at the facility as well.

II. Assessing Risk

The air in our atmosphere is ubiquitous and essential for biotic life. Additionally, it acts as a medium for the transport of airborne contamination and, therefore, constitutes an exposure pathway of potential concern. Models that can predict the fate and transport of chemical emissions in the atmosphere can provide an important tool for evaluating and

[14]OSWRO identified approximately 100 HAPs to be covered. This HAP list is a subset of the CAA Section 112 list.

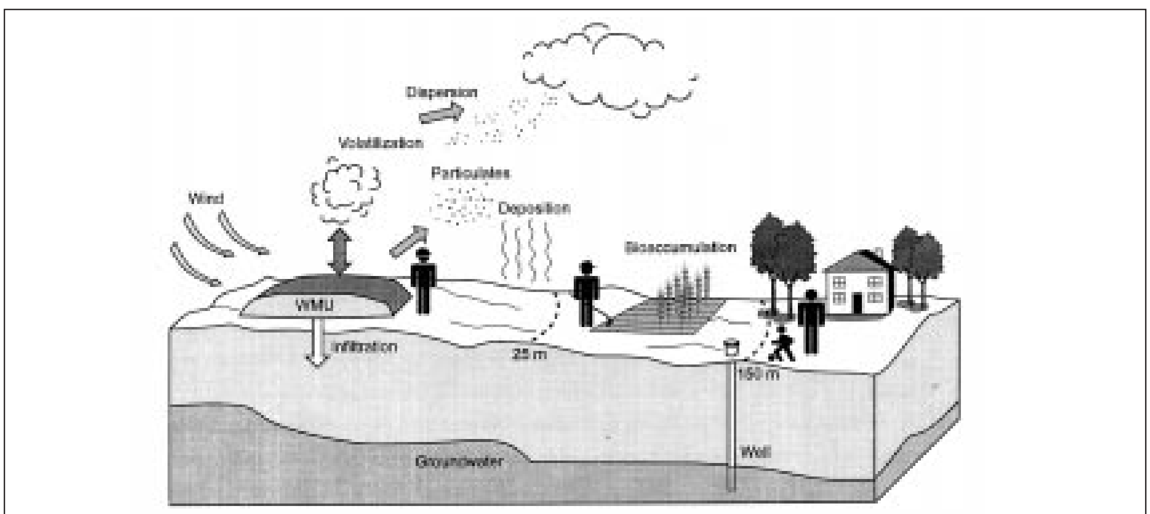
protecting air quality. Included in this guidance is the Industrial Waste Air Model (IWAIR). This model was developed to assist facility managers, regulatory agency staff, and the public in evaluating inhalation risks from waste management unit emissions. Although IWAIR is simple to use, it is still essential to understand the basic concepts of atmospheric modeling to be able to interpret the results and understand the nature of any uncertainties. The purpose of this section is to provide general information on the atmosphere, chemical transport in the atmosphere, and evaluation of risks associated with inhalation of chemicals so you can understand important factors to consider when performing a risk assessment for the air pathway.

From a risk perspective, it is unquestionable that humans are continuously exposed to air and the presence of chemicals in air is important to consider in any type of assessment. If pollutants build up to high concentrations in a localized area, human health may be compromised. The concentration of chemicals in a localized area and the resulting air pollution that may occur in the atmosphere is dependent upon the quantity and the rate of the emissions stream from a source and the ability of the air to disperse the chemicals. Both meteorological and geographic conditions in a local area will influence the emission rate and subsequent dispersion of a constituent. For example, the meteorologic stability of the atmosphere, a factor dependent on air temperature, influences whether the emission stream will rise and mix with a larger volume of air (resulting in the dilution of pollutants) or if the emissions stream will remain close to the ground. Figure 2 is a conceptual diagram of a waste site showing potential paths of human exposure through air.

A. Assessing Risks Associated with Inhalation of Ambient Air

In any type of risk assessment, there are basic steps that are necessary for gathering and evaluating data. These steps include: identification of chemicals of concern, source characterization, exposure assessment, and risk characterization. Each of these steps is described below as it applies specifically to risk resulting

Figure 2. Conceptual Site Diagram



from the inhalation of organic chemicals emitted from WMUs to the ambient air. This overview is presented to assist you in understanding conceptually the information discussed in the IWAIR section (Section II), since many of these steps will be automatically performed for you by the model.

Identification of Chemicals of Concern

A preliminary step in any risk assessment is the identification of chemicals of concern. These are the chemicals present that are anticipated to have potential health effects as a result of their concentrations and/or toxicity factors. An assessment is performed for a given source, to evaluate chemical concentrations and toxicity of different chemicals. Based on these factors along with potential mechanisms of transport and exposure pathways, the decision is made to include or exclude chemicals in the risk assessment. Toxicity benchmarks are identified in this step as well.

Source Characterization

In this step, the critical aspects of the source (e.g., type of WMU, size, chemical concentrations, location) are described. When modeling an area source, such as those included in this guidance, the amount of a given chemical that volatilizes and disperses from a source is critically dependent on the total surface area exposed. The source characterization should include information on the surface area and elevation of the unit. The volatilization is also dependent on other specific attributes related to the waste management practices. Waste management practices of importance include application frequency in land application units and the degree of aeration that occurs in a surface impoundment. The overall content of the waste being deposited in the WMU is also important in projecting volatilization since the nonvolatile component can, depending on its chemical characteristics, bind volatiles and prevent their emission to the ambient air. Source characterization involves defining each of these key parameters for the WMU being modeled. The accuracy of projections concerning volatilization of chemicals from WMUs into ambient air is improved if more site-specific information is used in characterizing the source.

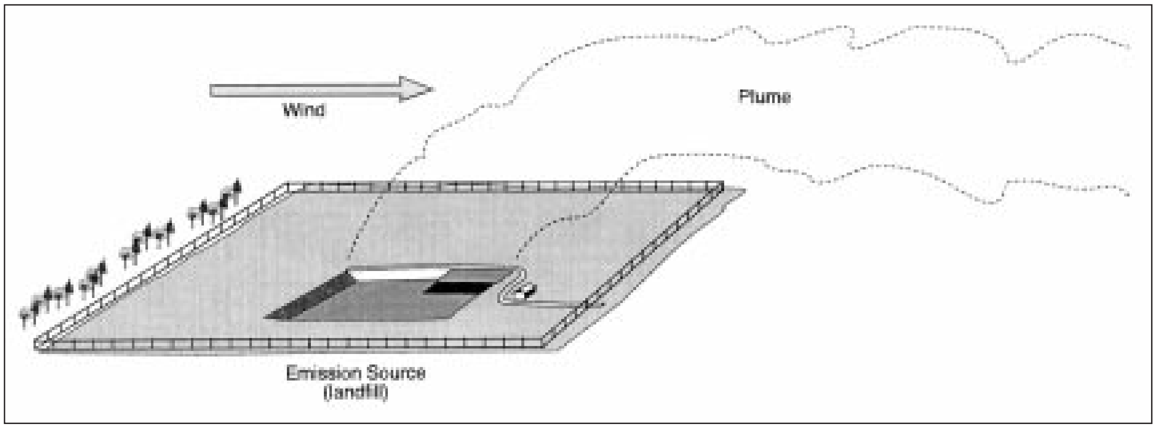
Exposure Assessment

The goal of an exposure assessment is to estimate the amount of a constituent that is available and is taken in by an individual, typically referred to as a receptor. An exposure assessment is performed in two steps: 1) the first step uses fate and transport modeling to determine the constituents concentration in air at a specified receptor location and, 2) the second step estimates the amount of the constituent the receptor will intake by identifying life-style activity patterns. The first step, the fate and transport modeling, uses a combination of an emission and dispersion model to estimate the amount of chemical that individuals residing and/or working within the vicinity of the source are exposed to through inhalation of ambient air. When a chemical volatilizes from a WMU into the ambient air, it is subjected to a number of forces that result in its diffusion and transport away from the point of release.

In modeling the movement of the volatile chemical away from the WMU, it is often assumed that the chemical behaves as a plume (i.e., the chemical is continuously emitted into the environment) whose movement and diffusion are modeled to produce estimated air concentrations at points of interest. This emission is illustrated in Figure 3.

The pattern of diffusion and movement of chemicals that volatilize from WMUs depends on a number of interrelated factors.

Figure 3. Emissions from a WMU



The ultimate concentration and fate of emissions to the air are most significantly impacted by three meteorologic conditions: atmospheric stability, wind speed, and wind direction. These meteorologic factors interact to determine the ultimate concentration of a pollutant in a localized area.

Atmospheric stability: The stability of the atmosphere is influenced by the vertical temperature structure of the air above the emission source. In a stable environment, there is little or no movement of air parcels, and, consequently, little or no movement and mixing of contaminants. In such a stable air environment, chemicals become "trapped" and unable to move. Conversely, in an unstable environment there is significant mixing and therefore greater dispersion and ultimately, dilution of the plume.[15]

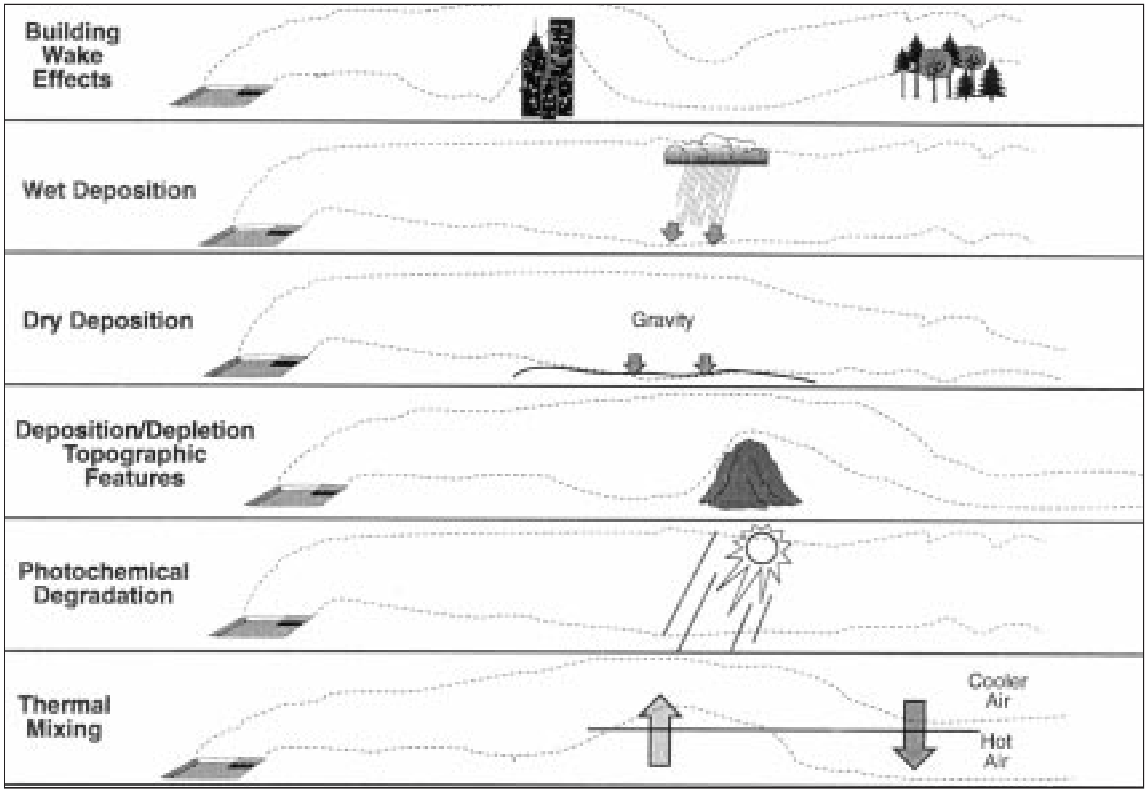
Prevailing wind patterns and their interaction with land features: The nature of the wind patterns immediately surrounding the WMU can significantly impact the local air concentrations of airborne chemicals. Prevailing wind patterns combine with topographic features such as hills and buildings to affect the movement of the plume. Upon release, the initial direction that emissions will travel is the direction of the wind. The strength of the wind will determine how dilute the concentration of the pollutant will be in that direction. For example, if a strong wind is present at the time the pollutants are released, it is likely the pollutants will rapidly leave the source and become dispersed quickly into a large volume of air.

In addition to these factors affecting the diffusion and transport of a plume away from its point of release, the concentration of specific chemicals in a plume can also be affected by depletion. As volatile chemicals are transported away from the WMU, they can be removed from the ambient air through a number of depletion mechanisms including wet deposition (the removal of chemicals due to precipitation) and dry deposition (the removal of chemicals due to the forces of gravity and impacts of the plume on features such as vegetation). Chemicals can also be transformed chemically as they come in contact with the sun's rays (i.e., photochemical degradation). Figure 4 illustrates the forces acting to transport and deplete the contaminant plume.

Because the chemicals being considered in IWAIR are volatiles and semi-volatiles and the distances of transport being considered are relatively short, the removal mechanisms shown in the figure are likely to have a relatively minor effect on plume concentration (both wet and dry deposition have significantly greater effects on airborne particulates)

[15]An example of an unstable air environment is one in which the sun shining on the earth's surface has resulted in warmer air at the earth's surface. This warmer air will tend to rise, displacing any cooler air that is on top of it. As these air parcels essentially switch places, significant mixing occurs.

Figure 4. Forces That Affect Contaminant Plumes.



and therefore are not considered.

Once the constituent's ambient outdoor concentration is determined, the receptor's extent of contact with the pollutant must be characterized. This step involves determining the location and activity patterns relevant to the receptor being considered. In IWAIR, the receptors are defined as residents and workers located at fixed distances from the WMU, and the only route of exposure considered for these receptors is the inhalation of volatiles. The activity patterns are used to determine the intake of the constituent. Intake estimates quantify the extent to which the individual is exposed to the contaminant and are a function of the breathing rate, exposure concentration, exposure duration, exposure frequency, exposure averaging time (for carcinogens), and body weight. Estimated exposures are presented in terms of the mass of the chemical per kilogram of receptor body weight per day.

Risk Characterization

The concentrations that an individual takes into his or her body that were determined during the exposure assessment phase are combined with toxicity values to generate risk estimates. Toxicity values used in IWAIR include inhalation-specific cancer slope factors (CSFs) for carcinogenic effects and reference concentrations (RfCs) for noncancer effects. These are explained in the general risk section under the building partnerships chapter. Using these toxicity values, risk estimates are generated for carcinogenic effects and noncancer effects. Risk estimates for carcinogens are summed by IWAIR.

B. IWAIR Model

IWAIR is an interactive computer program with three main components: an emissions model; a dispersion model to estimate fate and transport of constituents through the atmosphere and determine ambient air concentrations at specified receptor locations; and a risk model to calculate either the risk to exposed individuals or the waste constituent concentrations that can be protectively managed in the unit. The program requires only a limited amount of site-specific information, including facility location, WMU characteristics, waste characteristics, and receptor information. A brief description of each component follows. The IWAIR Technical Background Document contains a more detailed explanation of each.

1. Emissions Model

The emissions model uses waste characterization, WMU, and facility information to estimate emissions for 95 constituents. The emission model selected for incorporation into IWAIR is EPA's CHEMDAT8 model. This model has undergone extensive review by both EPA and industry representatives and is publicly available from EPA's Web page, <www.epa.gov/ttn/chief/software.html>.

To facilitate emission modeling with CHEMDAT8, IWAIR prompts the user to provide the required waste- and unit-specific data. Once these data are entered, the model calculates and displays chemical-specific emission rates. If users decide not to develop or use the CHEMDAT8 rates, they can enter their own site-specific emission rates (g/m^2-s).

2. Dispersion Model

IWAIR's second modeling component estimates dispersion of volatilized contaminants and determines air concentrations at specified receptor locations, using default dispersion factors developed with EPA's Industrial Source Complex, Short-Term Model, version 3 (ISCST3). ISCST3 was run to calculate dispersion for a standardized unit emission rate (1 $\mu g/m^2$ - s) to obtain a unitized air concentration (UAC), also called a dispersion factor, which is measured in μ/m^3 per $\mu g/m^2$ -s. The total air concentration estimates are then developed by multiplying the constituent-specific emission rates derived from CHEMDAT8 (or from another source) with a site-specific dispersion factor. Running ISCST3 to develop a new dispersion factor for each location/WMU is very time consuming and requires extensive meteorological data and technical expertise. Therefore IWAIR incorporates default dispersion factors developed by ISCST3 for many separate scenarios designed to cover a broad range of unit characteristics, including:

- 29 meteorological stations, chosen to represent the nine general climate regions of the continental U.S.;
- 4 unit types;
- 14 surface area sizes for landfills, land application units and surface impoundments, and 7 surface area sizes and 2 heights for waste piles;
- 6 receptor distances from the unit (25, 50, 75, 150, 500, 1000 meters) placed in...
- 16 directions in relation to the edge of the unit.

The default dispersion factors were derived by modeling many scenarios with various combinations of parameters, then choosing as the default the maximum dispersion factor for each waste management unit/surface area/meteorological station/receptor distance combination.

Based on the size and location of a unit, as specified by a user, IWAIR selects an appropriate dispersion factor from the default dispersion factors in the model. If the user specifies a unit surface area that falls between two of the sizes already modeled, a linear interpolation method will estimate dispersion in relation to the two closest unit sizes.

Alternatively, a user may enter a site-specific dispersion factor developed by conducting independent modeling with ISCST3 or with a different model and proceed to the next step, the risk calculation.

3. Risk Model

The third component to the model combines the constituent's air concentration with receptor exposure factors and toxicity benchmarks to calculate either the risk from concentrations managed in the unit or the waste concentration (C_w) in the unit that should not be exceeded to protect human health. In calculating either estimate, the model applies default values for exposure factors, including inhalation rate, body weight, exposure duration, and exposure frequency. These default values are based on data presented in EPA's *Exposure Factors Handbook* (U.S. EPA, 1997) and represent average exposure conditions. IWAIR maintains standard health benchmarks (cancer slope factors for carcinogens and reference concentrations for noncarcinogens) for 95 constituents. These health benchmarks are from the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1997a, 1998). The IWAIR uses these data to perform either a forward calculation to obtain risk estimates or a backward calculation to obtain protective waste concentration estimates.

4. Estimation Process

Figure 5 provides an overview of the stepwise approach the user follows to calculate risk or protective waste concentration estimates with IWAIR. The seven steps of the estimation process are shown down the right side of the figure, and the user input requirements are specified to the left of each step. As the user provides input data, the program proceeds to the next step. Each step of the estimation process is discussed below.

a. **Select Calculation Method.** Select one of two calculation methods. Use the forward calculation to arrive at chemical-specific and cumulative risk estimates if the user knows the concentrations of constituents in the waste. Use the backward calculation method to estimate protective waste concentrations not to be exceeded in new units. The screen where this step is performed is shown in Figure 6.

b. **Identify Waste Management Unit.** Four WMU types can be modeled: surface impoundments (SIs), land application units (LAUs), active landfills (LFs), and wastepiles (WPs). For each WMU, you will be asked to specify some design and operating parameters such as surface area, depth for surface impoundments and landfills, height for wastepiles, and tilling depth for LAUs. The amount of unit specific data needed as input will vary depending on whether the user elects to develop CHEMDAT8 emission rates. IWAIR provides default values for several of the operating parameters that the user may choose, if appropriate.

c. **Define Waste Managed.** Specify constituents and concentrations in the waste if you choose a forward calculation to arrive at chemical specific risk estimates. If you choose a backward calculation to estimate protective waste concentrations, then specify constituents of concern. The screen where this step is performed is shown in Figure 7.

Figure 5. IWAIR Approach for Developing Risk or Protective Waste Concentrations: This figure shows the steps in the tool to assist the user in developing risk or protective waste concentration estimates.

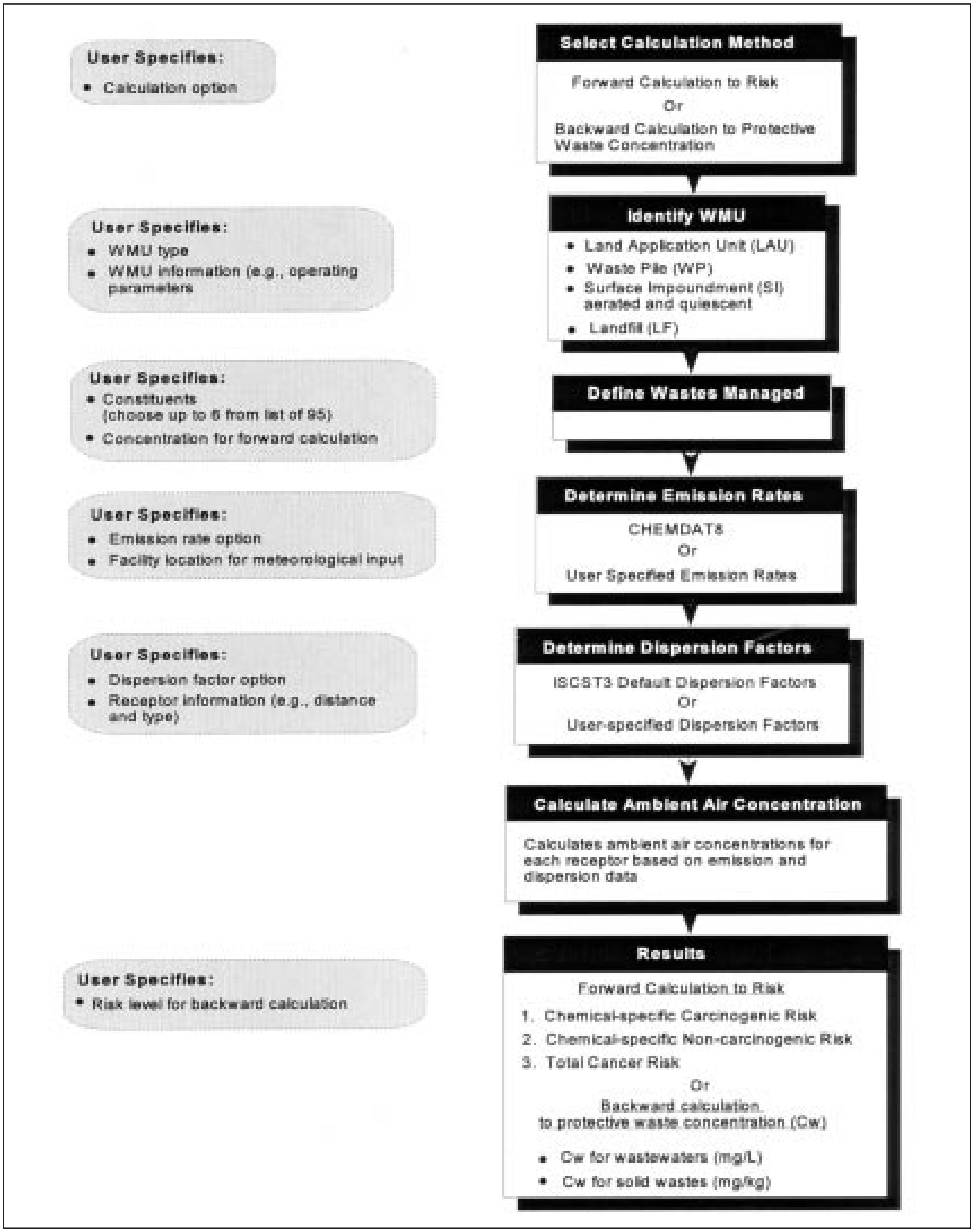


Figure 6. Screen 1, Method, Met Station. WMU.

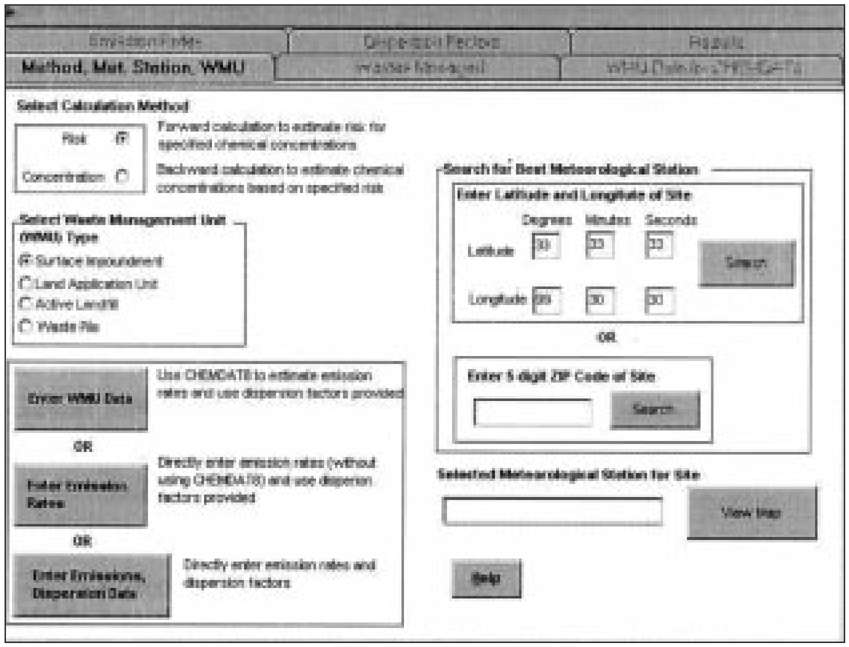
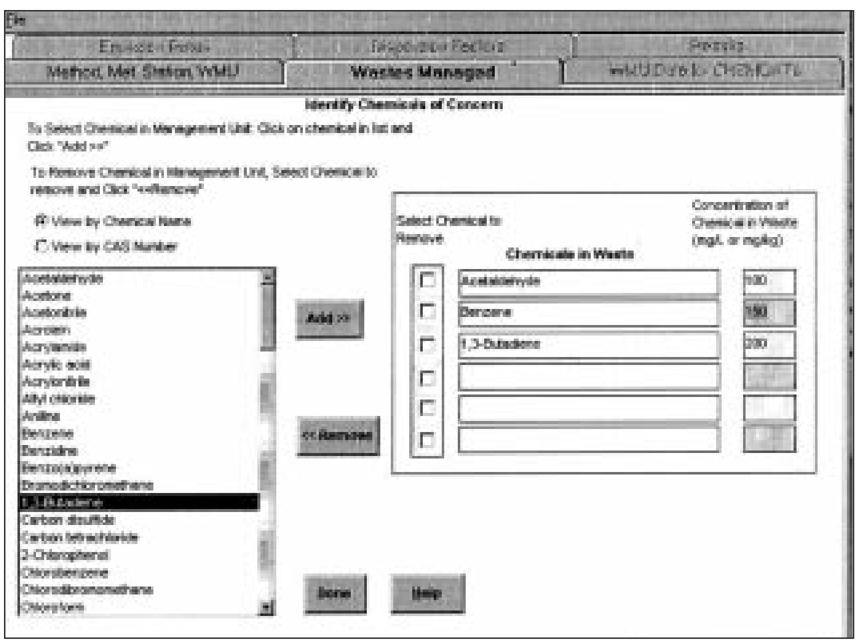


Figure 7. Screen 2, Waste Managed.



d. Determine Emission Rates. You can elect to develop CHEMDAT8 emission rates or provide your own site-specific emission rates for use in calculations. IWAIR will also ask for facility location information to link the facility's location to one of the 29 IWAIR meteorological stations. Data from the meteorological stations provide wind speed and temperature information needed to develop emission estimates. In some circumstances the user may already have emissions information from monitoring or a previous modeling exercise. As an alternative to using the CHEMDAT8 rates, a user may provide their own site-specific emission rates developed with a different model or based on emission measurements.

e. Determine Dispersion. The user can provide site-specific unitized dispersion factors (µg/m^3 per µg/m^2-s) or have the model develop dispersion factors based on user-specified WMU information and the IWAIR default dispersion data. Because a number of assumptions were made in developing the IWAIR default dispersion data (for example, flat terrain was assumed), you may elect to provide site-specific dispersion factors which can be developed by conducting independent modeling with ISCST3 or with a different model. Whether you use IWAIR or provide dispersion factors from another source, specify distance to the receptor from the edge of the WMU and the receptor type (i.e., resident or worker). These data are used to define points of exposure.

f. Calculate Ambient Air Concentration. For each receptor, the model combines emission rates and dispersion data to estimate ambient air concentrations for all waste constituents of concern.

g. Calculate Results. The model calculates results by combining estimated ambient air concentrations at a specified exposure point with receptor exposure factors and toxicity benchmarks. Presentation of results depends on whether you chose a forward or backward calculation:

Forward calculation: Results are estimates of cancer and non-cancer risks from inhalation exposure to volatilized constituents in the waste. If risks are too high, options are: 1) implement unit controls to reduce volatile air emissions; 2) implement pollution prevention or treatment to reduce volatile organic compound (VOC) concentrations before the waste enters the unit; or 3) conduct a full site-specific risk assessment to more precisely characterize risks from the unit.

Backward calculation: Results are estimates of constituent concentrations in waste that can be protectively managed in the unit so as not to exceed a defined risk level (e.g., 1×10^{-6} or hazard quotient of 1) for specified receptors. This information should be used to determine preferred characteristics for wastes entering the unit. There are several options if it appears that planned waste concentrations may be too high: 1) implement pollution prevention or treatment to reduce VOC concentrations in the waste; 2) modify waste management practices to better control VOCs (for example, use closed tanks rather than surface impoundments); or 3) conduct a full site-specific risk assessment to more precisely characterize risks from the unit.

5. Capabilities and Limitations of the Model

In many cases, IWAIR will provide a reasonable alternative to conducting a full-scale site-specific risk analysis to determine if a WMU poses unacceptable risk to human health. However, because the model can accommodate only a limited amount of site-specific information, it is important to understand it's capabilities and recognize situations when it may not be appropriate - when another model would be a better choice.

Capabilities

- The model provides a reasonable, conservative representation of VOC inhalation risks associated with waste management units.
- The model is easy-to-use and requires a minimal amount of data and expertise.
- The model is flexible and provides features to meet a variety of user needs:
  - A user can enter emission and/or dis persion factors derived from another model (perhaps to avoid some of the limitations below) and still use IWAIR to conduct a risk evaluation.
  - The model can run a forward calculation from the unit or a backward calculation from the receptor point.
  - A user can modify health benchmarks (HBNs) and target risk level, when appropriate and in consultation with other stakeholders.

Limitations

- **Chemicals of Concern.** If waste contains chemicals that (1) are not included in the model and (2) have human health effects and may be present in concentrations sufficient to pose a risk to public health via inhalation exposure, the model will not fully characterize risks for that WMU since these additional chemicals would be excluded from consideration.
- **Release Mechanisms and Exposure Routes.** The model considers exposures from breathing ambient air. It does not address potential risks attributable to particulate releases nor does it address risks associated with indirect routes of exposure (i.e, non-inhalation routes of exposure). Additionally, in the absence of user-specified emission rates, volatile emission estimates are developed with CHEMDAT8 based on unit- and waste-specific data. The CHEMDAT8 model was developed to address only volatile emissions from waste management units. Competing mechanisms such as runoff, erosion, and leaching are not accounted for in the model. In so much as these competing processes actually occur, the model would tend to slightly overestimate the volatile emissions. On the other hand, one could interpret this situation as being representative of WMUs that have leachate controls, such as liners, or erosion and runoff controls. Such controls would tend to inhibit these processes and result in more volatile emissions.
- **Waste Management Practices.** The user specifies a number of unit-specific parameters that significantly impact the inhalation pathway (e.g., size, type, and location of WMU, which is important in identifying meteorological conditions). However, the model cannot accommodate information concerning control technologies such as covers that might influence the degree of volatilization (e.g., whether a wastepile is covered immediately after application of new waste). In this case, it may be necessary to generate site-specific emission rates and enter those into IWAIR.
- **Terrain and Meteorological Conditions.** If a facility is located in an area of intermediate or complex terrain or with unusual meteorological conditions, it may be necessary to either (1) generate site-specific

air dispersion modeling results for the site and enter those results into the program, or (2) use a site-specific risk modeling approach different from IWAIR. The model will inform the user which of the 29 meteorological stations is used for a facility. If the local meteorological conditions are very different from the site chosen by the model, it would be more accurate to choose a different model.

The terrain type surrounding a facility can impact air dispersion modeling results and ultimately risk estimates. In performing air dispersion modeling to develop the IWAIR default dispersion factors, it was assumed that the facility was located in an area of simple or flat terrain. The Guideline on Air Quality Models (U.S. EPA, 1993) can assist users in determining whether a facility is in an area of simple, intermediate, or complex terrain.

- **Receptor Type and Location.** IWAIR has predetermined adult worker and resident receptors, six receptor locations, and predetermined exposure factors. The program cannot be used to characterize risk for other possible exposure scenarios. For example, the model can not evaluate receptors that are closer to the unit than 25 meters or those that are further from the unit that 1000 meters.

C. Site-specific Risk Analysis

IWAIR is not the only model that may be applicable to a site. In some cases, a site-specific risk assessment may be more advantageous. A site-specific approach can be tailored to accommodate the individual needs of a particular WMU. Such an approach would rely on site-specific data and on the application of existing fate and transport models.

Table 5 summarizes available emissions and/or dispersion models that may be applied in a site-specific analysis. Practical considerations include the source of the model(s), the ease in obtaining the model(s), and the nature of the model(s) (i.e., is it proprietary), and the availability of site-specific data required for use of the model. Finally, the model selection process should determine whether or not the model has been verified against analytical solutions, other models, and/or field data. Proper models can be selected based on the physical and chemical attributes of the site in question. However, as with all modeling, the state authority should be consulted prior to investing significant resources in a site-specific analysis. The state may have preferred models and/or may be able to help plan the analysis.

III. Emission Control Techniques

A. Controlling Particulate Matter (PM)

PM consists of airborne solid and liquid particles. When PM is very small, it is easily inhaled and trapped in the lungs, where it can cause various health problems. PM also impacts the environment by decreasing visibility and harming plants as well as transporting hazardous constituents offsite. We recommend that facilities adopt controls to address emissions of airborne particulates.

Solid PM that becomes airborne directly or indirectly as a result of human activity, is referred to as fugitive dust[16] and it can be generated from a number of different sources. The most common sources of fugitive dust at waste management units include vehicular traffic on unpaved roads and land-based units, wind erosion from land-based units, and waste handling procedures. Developing a fugitive dust

[16]Fugitive emissions are defined as emissions not caught by a capture system and therefore exclude PM emitted from exhaust stacks with control devices.

Table 5
Source Characterization Models

Model Name	Summary
CHEMDAT8	The CHEMDAT8 model allows the user to conduct source and chemical specific emissions modeling. CHEMDAT8 is a Lotus 1-2-3 spreadsheet that includes analytical models to estimate volatile organic compound emissions from treatment, storage, and disposal facility processes under user-specified input parameters. CHEMDAT8 calculates the fractions of waste constituents of interest that are distributed among pathways (partition fractions) applicable to the facility under analysis. Emissions modeling using CHEMDAT8 is conducted using data entered by the user for unit-specific parameters. The user may choose to override the default data and enter their estimates for these unit-specific parameters. Thus, modeling emissions using CHEMDAT8 can be done with a limited amount of site-specific information. Available at **<www.epa.gov/ttn/chief/software.html>**, hotline at (919) 541 5610 for more information.
ISCST3	A steady-state Gaussian plume dispersion model that can estimate concentration, dry deposition rates (particles only), and wet deposition rates. Is applicable for continuous emissions , industrial source complexes, rural or urban areas, simple or complex terrain, transport distances of less than 50 km, and averaging times from hourly to annual Available at **<www.epa.gov/scram001/>**
COMPDEP	The COMPDEP model was developed to calculate air concentration and deposition fluxes, particularly in areas of complex terrain. This model uses standard meteorological data to produce estimates of annual average concentration, total annual dry deposition, and wet deposition flux at individual receptor sites. COMPDEP accounts for pollutant deposition and terrain adjustments. This model was developed for and is only applicable in rural areas. Available at **<www.epa.gov/scram001/>**
Toxic Screening Model (TSCREEN)	Performs emission rate, pool evaporation , and natural and dense gas dispersion calculations. TSCREEN uses simple methods, and therefore is primarily used for screening. Little or no modeling experience is required to use this model.

Source: **<www.epa.gov/rgytgrnj/programs/artd/toxics/arpp/etools.htm>**

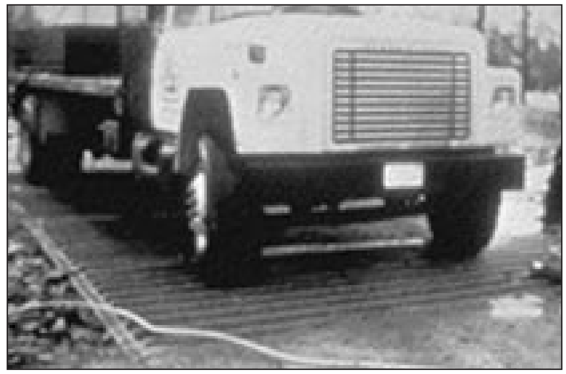
control plan is an efficient way to tackle these problems. The plan should include a description of all operations conducted at the unit, a map, a list of all fugitive dust sources at the unit, and a description of the control measures that will be used to minimize fugitive dust emissions. OSHA has established standards for occupational exposure to dust (see 29 CFR § 1910.1000). Check to see if the state also has regulations or guidance concerning dust or fugitive emission control.

PM emissions at waste management units vary with the physical and chemical characteristics of waste streams; the volume of waste handled; the size of the unit, its location, and associated climate; and waste transportation and placement practices. The subsections below discuss the main PM-generating operations and identify emission control techniques.

1. Vehicular Operations

Waste and cover material are often transported to units using trucks. If the waste has the potential for PM to escape to the atmosphere during transport, cover the waste with tarps or place wastes in containers such as double bags or drums[17]

A unit may also use vehicles to construct lifts in landfills, apply liquids to land application units, or dredge surface impoundments. Consider using "dedicated" equipment—vehicles that operate only within the unit and are not routinely removed from the unit to perform other activities. This practice reduces the likelihood that equipment movement will spread contaminated PM outside the unit. To control PM emissions when equipment must be removed from the landfill unit, such as for maintenance, a wash station can remove any contaminated material from the equipment before it leaves the unit. Ensure that this is done in a curbed wash area where wash water is captured and properly handled.



To minimize PM emissions from all vehicles, construct temporary roadways with gravel or other coarse aggregate material to reduce silt content and thus, dust generation. In addition, consider regularly cleaning paved roads and other travel surfaces of dust, mud, and contaminated material.

In land application units, the entire application surface is often covered with a soil-waste mix. The most critical preventive control measure, therefore, involves minimizing contact between the application surface and waste delivery vehicles. If possible, allow only dedicated application vehicles on the surface, restricting delivery vehicles to a staging or loading area where they deposit waste into application vehicles or holding tanks. If delivery vehicles must enter the application area, ensure that mud and waste are not tracked out and deposited on roadways, where they can dry and then be dispersed by wind or passing vehicles.

2. Waste Placement and Handling

PM emissions from waste placement and handling activities are less likely if exposed material has a high moisture content. Therefore, consider wetting the waste prior to loadout. Increasing the moisture content, however, may not be suitable for all waste streams, as water could cause an adverse

[17]Containerizing wastes provides highly effective control of PM emissions, but, due to the large volume of many industrial waste streams, containerizing waste may not always be feasible.

chemical reaction with some wastes or unacceptably increase leachate production. To reduce the need for water or suppressants, cover or confine freshly exposed material. In addition, consider increasing the moisture content of the cover material.

It can also be useful to apply water to unit surfaces after waste placement. Water is generally applied using a truck with a gravity or pressure feed. Watering may or may not be advisable depending on application intensity and frequency, the potential for tracking of contaminated material off site, and climatic conditions. PM control efficiency generally increases with application intensity and frequency but also depends on activity levels, climate, and initial surface conditions. Infrequent or low-intensity water application may provide little effective control, while too frequent or high-intensity application may increase leachate volume, straining leachate collection systems and threatening ground water and surface water. Addition of excess water to bulk waste material or to unit surfaces also can reduce the structural integrity of the landfill lifts, increase tracking of contaminated mud off site, and worsen odor. These undesirable possibilities may have long-term implications for the proper management of a unit. Before instituting a watering program, therefore, ensure that addition of water does not produce undesirable impacts on ground- and surface-water quality. Consult with your state agency with respect to these problems.

Chemical dust suppressants are an alternative to water application. The suppressants are detergent-like surfactants that increase the total number of droplets and allow particles to more easily penetrate the droplets, increasing the total surface area and contact potential. Adding a surfactant to a relatively small quantity of water and mixing vigorously produces small-bubble, high-energy foam in the 100 to 200 μm size range. The foam occupies very little liquid volume, and when applied to the surface of the bulk material, wets the fines more effectively than water. When applied to a unit, suppressants cement loose material into a more impervious surface or form a surface which attracts and retains moisture. Examples of chemical dust suppressants are provided in Appendix IV . The degree of control achieved is a function of the application intensity and frequency and the dilution ratio. Chemical dust suppressants tend to require less frequent application than water, reducing the potential for leachate generation. Their efficiency varies, depending on the same factors as water application, as well as spray nozzle parameters, but generally falls between 60 and 90 percent reduction in fugitive dust emissions. Suppressant costs, however, can be high.

At land application units, if wastes contain considerable moisture, PM can be suppressed through application of more waste rather than water or chemical suppressants. This method, however, is only viable if it would not cause an exceedence of a design waste application rate or exceed the capacity of soil and plants to assimilate waste.

At surface impoundments, the liquid nature of the waste means PM is not a major concern while the unit is operational. Inactive or closed surface impoundments, however, may emit PM during scraping or bulldozing operations to remove residual materials. The uppermost layer of the low permeability soils, such as compacted clay, which may be used to line a surface impoundment, contains the highest contaminant concentrations. Particulate emissions from this uppermost layer, therefore, are the chief contributor to contaminant emissions. When removing residuals from active units, ensure that equipment scrapes only the residuals, avoiding the liner below.

3. Wind Erosion

Wind erosion occurs when a dry surface is exposed to the atmosphere. The effect is most pronounced with bare surfaces of fine particles, such as silty soil; heavier or better anchored material, such as stones or clumps of vegetation, has limited erosion potential and requires higher wind speeds before erosion can begin.

Compacted clay and in-situ soil liners tend to form crusts as their surfaces dry. Crusted surfaces usually have little or no erosion potential. Examine the crust thickness and strength during site inspections. If the crust is more than ¼ inch thick and does not crumble easily, then the soil probably has almost no erosion potential.

Wind fences or barriers are effective means by which to control fugitive dust emissions from open dust sources. The wind fence or barrier reduces wind velocity and turbulence in an area whose length is many times the height of the fence. This allows settling of large particles and reduces emissions from the exposed surface. It can also shelter materials handling operations to reduce entrainment during load-in and loadout. Wind fences or barriers can be portable and either man-made structures or vegetative barriers, such as trees. A number of studies have attempted to determine the effectiveness of wind fences or barriers for the control of windblown dust under field conditions. Several of these studies have shown a decrease in wind velocity, however, the degree of emissions reduction varies significantly from study to study depending on test conditions.

Other wind erosion control measures include passive enclosures such as three-sided bunkers for the storage of bulk materials, storage silos for various types of aggregate material, and open-ended buildings. Such enclosures are most easily used with small, temporary waste piles. At land application units that use spray application, further wind erosion control can be achieved simply by not spraying waste on windy days.

Windblown PM emissions from a waste pile depend on how frequently the pile is disturbed, the moisture content of the waste, the proportion of aggregate fines, and the height of the pile. When fine-particle wastes are loaded onto a waste pile, the potential for dust emissions is at a maximum, as fine particles are easily disaggregated and picked up by wind. This tends to occur when material is either added to or removed from the pile or when the pile is otherwise reshaped. On the other hand, when the waste remains undisturbed for long periods and is weathered, its potential for dust emissions may be greatly reduced. This occurs when moisture from precipitation and condensation causes aggregation and cementation of fine particles to the surface of larger particles, and when vegetation grows on the pile, shielding the surface and strengthening it with roots. Finally, limiting height of the pile can reduce PM emissions, as wind velocities generally increase with distance from the ground.

B. VOC Emission Control Techniques

If air modeling indicates that VOC emissions are a concern, consider pollution prevention and treatment options to reduce risk. There are several control techniques you can use. Some are applied before the waste is placed in the unit, reducing emissions; others contain emissions that occur after waste placement; still others process the captured emissions.

1. Choosing a Site to Minimize Airborne Emission Problems

Careful site choice can reduce VOC emissions. Look for locations that are sheltered from wind by trees or other natural features. Know the direction of prevailing winds and determine whether the unit would be upwind from existing and expected future residences, businesses, or other population centers. After a unit is sited, observe wind direction during waste placement, and plan or move work areas accordingly to reduce airborne emission impacts on neighbors.

2. Pretreatment of Waste

Pretreating waste can remove organic compounds and possibly eliminate the need for further air emission controls. Organic removal or pretreatment is feasible for a variety of wastes. These processes, which include steam or air stripping, thin-film evaporation, solvent extraction, and distillation, can sometimes remove essentially all of the highly volatile compounds from your waste. Removal of the volatiles near the point of generation may obviate the need for controls on your subsequent process units and may facilitate recycling the recovered organics back to the process.

The control efficiency of organic removal depends on many factors, such as emissions from the removal system, and the uncontrolled emissions from management units before the removal device was installed. Generally, overall organic removal efficiencies of 98 to over 99 percent can be achieved.

3. Enclosure of Units

You may be able to control VOC emissions from your landfill or waste pile by installing a flexible membrane cover, enclosing the unit in a rigid structure, or using an air-supported structure. Fans maintain positive pressure to inflate an air-supported structure. Some of the air-supported covers that have been used consist of PVC-coated polyester with a polyvinyl fluoride film backing. The efficiency of air-supported structures depends primarily on how well the structure prevents leaks and how quickly any leaks that do occur are detected. For effective control, the air vented from the structure should be sent to a control device, such as a carbon adsorber. Consider worker safety issues related to access to the interior of any flexible membrane cover or other pollutant concentration system.

Wind fences or barriers may also aid in reducing organic emissions by reducing air mixing on the leeward side of the screen. In addition, wind fences reduce soil moisture loss due to wind, which may in turn result in decreased VOC emissions.

Floating membrane covers provide control on various types of surface impoundments, including water reservoirs in the western United States. For successful control of organic compounds, the membrane must provide a seal at the edge of the impoundment and rainwater must be removed. If gas is generated under the cover, vents and a control device may also be needed. Emission control depends primarily on the type of membrane, its thickness, and the nature of the organic compounds in the waste. One study tracked a membrane cover made of 100-mil high-density polyethylene extended over a concrete ring wall that extended above grade level around the perimeter of the impoundment, and covered with backfill to anchor and seal it. Theoretical estimates based on diffusion through the membrane indicate control efficiencies of 50 to 95 percent. Again, consult with your state or local air quality agency to identify the most appropriate emission control for your impoundment.

4. Treatment of Captured VOCs

In some cases, waste will still emit some VOCs despite waste reduction or pretreatment efforts. Enclosing the unit serves to prevent the immediate escape of these VOCs to the atmosphere. To avoid eventually releasing VOCs through an enclosure's ventilation system, a treatment system is necessary. We discuss some of the better-known treatment methods below; others also may be available.

a. Adsorption

Adsorption is the adherence of particles of one substance, in this case VOCs, to the surface of another substance, in this case a filtration or treatment matrix. The matrix can be replaced or flushed when its surface becomes saturated with the collected VOCs.

Carbon Adsorption. In carbon adsorption, organics are selectively collected on the surface of a porous solid. Activated carbon is a common adsorbent because of its high internal surface area: 1 gram of carbon can have a surface area equal to that of a football field and can typically adsorb up to half its weight in organics. For adsorption to be effective, replace, regenerate, or recharge the carbon when treatment efficiency begins to decline. In addition, any emissions from the disposal or regeneration of the carbon should be controlled. Control efficiencies of 97 to 99 percent have been demonstrated for carbon adsorbers in many applications.

Biofiltration. While covering odorous materials with soil is a longstanding odor control practice, the commercial use of biofiltration is a relatively recent development. Biofilters reproduce and improve upon the soil cover concept used in landfills. In a biofilter, gas emissions containing biodegradable VOCs pass through a bed packed with damp, porous organic particles. The biologically active filter bed then adsorbs the volatile organic compounds. Microorganisms attached to the wetted filter material aerobically degrade the adsorbed chemical compounds. Biofiltration may be a highly effective and low-cost alternative to other, more conventional, air pollution control technologies such as thermal oxidation, catalytic incineration, condensation, carbon adsorption, and absorption. Successful commercial biofilter applications include treatment of gas emissions from composting operations, rendering plants, food and tobacco processing, chemical manufacturing, foundries, and other industrial facilities.[18]

b. Condensation

Condensers work by cooling the vented vapors to their dew point and removing the organics as liquids. The efficiency of a condenser is determined by the vapor phase concentration of the specific organics and the condenser temperature. Two common types of condensers are contact condensers and surface condensers.

c. Absorption

In absorption, the organics in the vent gas dissolve in a liquid. The contact between the absorbing liquid and the vent gas is accomplished in spray towers, scrubbers, or packed or plate columns. Some common solvents that may be useful for volatile organics include water, mineral oils, or other nonvolatile petroleum oils. Absorption efficiencies of 60 to 96 percent have been reported for organics. The material removed from the absorber may present a disposal or separation problem. For example, organics must be removed from the water or nonvolatile oil without losing them as emissions during the solvent recovery or treatment process.

d. Vapor Combustion

Vapor combustion is another control technique for vented vapors. The destruction of

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[18]Mycock, J.C., J.D. McKenna, and L. Theodore. 1995. *Handbook of Air Pollution Control Engineering and Technology.*

organics can be accomplished in flares; thermal oxidizers, such as incinerators, boilers, or process heaters; and in catalytic oxidizers. Flares are an open combustion process in which oxygen is supplied by the air surrounding the flame. Flares are either operated at ground level or elevated. Properly operated flares can achieve destruction efficiencies of at least 98 percent. Thermal vapor incinerators can also achieve destruction efficiencies of at least 98 percent with adequately high temperature, good mixing, sufficient oxygen, and an adequate residence time. Catalytic incinerators provide oxidation at temperatures lower than those required by thermal incinerators. Design considerations are important because the catalyst may be adversely affected by high temperatures, high concentrations of organics, fouling from particulate matter or polymers, and deactivation by halogens or certain metals.

5. Special Considerations for Land Application Units

Since spraying wastes increases contact between waste and air, promoting VOC emissions, you may want to choose another application method, such as subsurface injection, if the waste contains volatile organics. During subsurface injection, waste is supplied to the injection unit directly from a remote holding tank and injected approximately 6 inches into the soil; hence, the waste is not exposed to the atmosphere. In addition, consider pretreating the waste to remove the organics before placing it in the land application unit.

Protecting Air Quality Action Items

Consider the following issues when evaluating and controlling air emissions from nonhazardous industrial waste management units:

- ❑ Understand air pollution laws and regulations, and determine whether and how they apply to a unit.
- ❑ Evaluate waste management units to identify possible sources of volatile organic emissions.
- ❑ Work with your state agency to evaluate and implement appropriate emission control techniques, as necessary.

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Part 3
Protecting Surface Water

Chapter 6
Protecting Surface Water

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Protecting Surface Water

Protect surface waters by limiting the discharge of pollutants into the waters of the United States. Guard against inappropriate discharges of pollutants associated with process wastewaters and storm water to ensure the safety of the nation's surface waters. Reduce storm water discharges by complying with regulations, implementing available storm water controls, and identifying best management practices (BMPs) to control storm water.

Over 70 percent of the Earth's surface is water. Of all the Earth's water, 97 percent is found in the oceans and seas, while three percent is fresh water. This fresh water is found in glaciers, lakes, ground water, and rivers. Water offers many valuable uses to individuals and communities. Water is necessary for recreational needs, drinking water demands, fishing, commerce, agriculture, and the overall quality of life.

> This chapter will help address the following questions:
>
> • What are the objectives of run-on and run-off control systems?
>
> • What should be considered in designing surface-water protection systems?
>
> • What are the appropriate BMPs to address pollutant sources?
>
> • What are some of the engineering and physical mechanisms available to control storm water?

With water being such a valuable commodity, the protection of our surface waters should be everyone's goal. This goal can be achieved by everyone focusing on improving the quality of our surface waters. Improvements in the quality of our surface waters can be achieved by the continued protection against the discharge of pollutants. Pollutants associated with process wastewaters and storm waters need to be controlled.

This chapter summarizes the existing federal surface-water protection programs. The majority of this chapter then discusses methods that can be used to eliminate pollutant discharges into surface waters associated with storm-water management. Controlling storm-water run-on and run-off from waste management units minimizes contamination of surface water. Use best management practices (BMPs) in conjunction with engineering and physical mechanisms to control storm water and reduce or eliminate contaminant releases to the environment.

I. Federal Surface-Water Protection Programs

The federal Clean Water Act (CWA) governs the discharge of all pollutants into waters of the United States, such as lakes, rivers, streams, wetlands, ponds, or lagoons. It does so primarily through a permitting process known as the National Pollutant Discharge Elimination System (NPDES). All entities that discharge pollutants of any kind into waters of the United States must have an NPDES permit. Permits are issued for three types of wastewaters: process wastewater, nonprocess wastewater, and storm water. Permits typically set forth specific "effluent limitations" relating to the type of discharge. For process wastewaters, the permit incorporates the more stringent of industry-specific, technology-based limitations, which can be found at 40 CFR Parts 405-471, or water quality-based effluent limits (WQBELs).[1] NPDES permits also set forth monitoring and reporting requirements. Some waste management units, such as surface impoundments, may receive an NPDES permit to discharge wastewaters directly to surface waters. Other units may need an NPDES permit only for storm-water discharges. For industrial facilities that discharge wastewaters to Publicly Owned Treatment Works (POTW) through domestic sewer lines, pretreatment of the wastewater may be required. Under the National Pretreatment Program, EPA, the state, and the local regulatory agency establish discharge limits to reduce the level of pollutants discharged by industry into municipal sewer systems. These limits control pollutant levels reaching a POTW, improving the quality of the effluent and sludges produced by the POTW. Protecting the POTW and improving effluent and sludge quality significantly increases the opportunity for beneficial reuse of these end products. A fact sheet and frequently asked questions on industrial pretreatment is included in the Appendix I for this chapter, and are available on the Office of Wastewater Management's web page at **<www.epa.gov/owm/pre.htm>**.

As mentioned previously, some units may be required to obtain an NPDES permit for storm-water discharges. EPA has defined 11 categories under the definition of "storm water associated with industrial activity" (40 CFR §122.26(b)(14)) that require an NPDES storm-water permit for discharges to navigable waters. These 11 categories consist of: (1) facilities subject to storm-water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR Part 129 (manufacturers of 6 specific pesticides); (2) "heavy" manufacturing facilities; (3) mining and oil and gas operations with "contaminated" storm-water discharges; (4) hazardous waste treatment, storage, or disposal facilities; (5) landfills, land application sites, and open dumps; (6) recycling facilities; (7) steam electric generating facilities; (8) transportation facilities; (9) sewage treatment plants; (10) construction operations disturbing five or more acres; and (11) other industrial facilities where materials are exposed to storm water. Nonhazardous waste landfills and land application units would fall under category 5.

Most surface impoundments that are addressed by this guidance are part of an industrial wastewater treatment process that results in an NPDES-permitted discharge into surface waters. The NPDES permit only sets pollution limits for the final discharge of treated wastewater. It does not establish any regulatory requirements for design or operation of surface impoundments that are part of the treatment process such as liners and ground-water monitoring. Individual state environmental agencies, under their own statutory authorities, may

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[1] Facilities that discharge wastewaters to publicly-owned treatment works (POTWs) may be subject to pretreatment requirements found in 40 CFR Part 403.

impose such requirements on surface impoundment design and operation.

To provide flexibility for the regulated community in acquiring storm-water discharge permits, EPA has two NPDES permit application options: individual permits and general permits.[2] Applications for individual permits require the submission of a site drainage map, a narrative description of the site that identifies potential pollutant sources, and quantitative testing data for specific parameters. General permit applications usually involve the submission of a Notice of Intent (NOI) that includes only general information, not industry-specific or pollutant-specific BMPs, and typically do not require collection of monitoring data. NPDES general storm-water permits require the development and implementation of storm-water pollution prevention plans and BMPs to limit pollutants in storm-water discharges. EPA has issued the Multi-Sector General Permit (60 *Federal Register* 50803; September 29, 1995) which covers 29 different industry sectors. The Agency reviewed, on a sector-by-sector basis, information concerning industrial activities, BMPs, materials stored outdoors, and end-of-pipe storm-water sampling data. Based on this review, EPA identified pollutants of concern in each industry sector, sources of these pollutants, and BMPs used to control them. The Multi-Sector General Permit requires the submission of an NOI, development and implementation of a site-specific pollution prevention plan as the basic storm-water control strategy for each industry sector.

Sometimes it may be appropriate to "pre-treat" the storm water before discharging it into municipal separate storm sewer systems. Using proven pollution control technologies, practices that promote reuse and recycling of material, and wastewater treatment, pollutants from storm water can be reduced or eliminated before it is discharged. NPDES permits for "storm-water discharges associated with industrial activity" (as previously defined) are issued by EPA or states with NPDES permitting authority. If located in a state with NPDES authority, contact the state directly to determine the requirements for storm water discharges. EPA's Office of Wastewater Management's web page contains a complete, updated list of the states with approved NPDES permit programs, as well as fact sheets and frequently asked questions on the NPDES permit program. These facts sheets can be found at **<www.epa.gov/owm/npdes.htm>**, and are included in the Appendix III for this chapter . If a state does not have NPDES permitting authority, follow any state requirements for storm-water discharges and contact EPA to determine applicable federal requirements for storm-water discharges.

If a waste management unit is subject to federal or state storm-water discharge requirements, use this chapter as an aid in complying with applicable storm-water

Is a permit needed?

To answer questions about whether or not a facility needs to seek permit coverage, or to determine whether a particular program is administered by EPA or a state agency, contact the state or EPA regional storm water official listed in the Appendix II. Currently, 42 states and the U.S. Virgin Islands have federally approved state NPDES permit programs. The following 8 states do not have final EPA approval: Alaska, Arizona, Idaho, Maine, Massachusetts, New Hampshire, New Mexico and Texas.

[2]Initially a group application procedure was available for facilities with similar activities to jointly submit a single application for permit coverage. A multi-sector general permit was then developed based upon information provided in the group applications. The group application option was only for use in the initial stages of the program and is no longer available.

discharge requirements and maintaining appropriate surface-water controls. If a unit is not subject to federal or state storm-water discharge requirements, use this information to proactively develop surface-water protection systems.

II. Overview of Storm-Water Protection Systems

Protecting surface water entails preventing storm-water contamination during both unit construction and the operational life of the waste management unit. The primary run-off contaminant during construction is sediment eroded from exposed soil surfaces. Temporary sediment and erosion control measures, such as silt fences around construction perimeters, straw bales around storm-water inlets, and seeding or straw covering of exposed slopes, are typically used to limit and manage erosion. States or localities often require the use of sediment and erosion controls at any construction site disturbing greater than a certain number of acres, and may have additional requirements in especially sensitive watersheds. Consult with the state and local regulatory agency to determine sediment and erosion control requirements for construction.

Once a waste management unit has been constructed, permanent run-on and run-off controls are necessary to protect surface water. Run-on controls are designed to prevent storm water from entering active areas of units. If run-on is not prevented from entering active areas, it may seep into the waste and increase the amount of leachate that must be managed. It can also deposit contaminants from nearby sites, such as pesticide from adjoining farms, further burdening treatment systems. Excessive run-on may also damage earthen containment systems, such as covers and berms. Run-on that contacts the waste may carry contaminants into receiving waters through surface-water run-off or into ground

What is “run-on”?

Run-on is a term used to refer to water from outside a waste management unit that flows toward the unit. Run-on encompasses storm water from rainfall or the melting of snow or ice that falls directly on the unit as well as the water that drains from adjoining areas.

Why are run-on controls necessary?

Run-on controls are designed to prevent (1) contamination of storm water, (2) erosion that may damage the physical structure of units, (3) the surface discharge of waste constituents, (4) the creation of leachate, and (5) already contaminated surface water from entering the unit.

What is “run-off”?

Run-off is a term used to refer to water or leachate that drains or flows over land from any part of a waste management unit. Run-off can be created by rainfall, or the melting of snow and ice.

What is the purpose of a “run-off” control system?

Run-off control systems are designed to collect and control at least the water flow resulting from a storm event of a specified duration, such as a 24-hour, 25 year storm event.

water through infiltration. The Multi-Sector General Permit does not authorize discharges of leachate, which includes storm water which contacts waste. The discharge of leachate would be regulated under either an individually drafted NPDES permit with site-specific discharge limitations, or an alternative NPDES general permit if one is available. Divert run-on by taking advantage of natural contours or by constructing ditches or berms designed to intercept and drain storm water. Run-on diversion systems should be designed to handle the peak discharge of a design storm event, such as a 25-year storm. (See Section IV for more information about design storm events.)

Run-off controls channel, divert, and convey storm water to treatment facilities, if appropriate, and to intended discharge points. Manage run-off from a waste management unit as a potentially contaminated material. Due to the potential for contamination, manage contact run-off from active areas of a landfill or waste pile as leachate. Design the leachate collection and removal systems to handle such run-off, as well as any leachate generated. Segregate noncontact run-off to reduce the volume that may need to be handled as leachate. Design surface impoundments with sufficient freeboard and adequate capacity to accommodate not only waste but also precipitation. For land application sites, run-off from the application site may adversely affect nearby surface waters.

III. Best Management Practices for Waste Management Units

Evaluation of BMPs should be considered in both the design and operation of a waste management unit. Before identifying and implementing BMPs, assess potential sources of storm-water contamination. Two of the most common sources of contamination from waste management units are erosion and sediment discharges caused by storm events. To conduct a thorough assessment, create a map of the waste management unit area, review operating practices, and consider the design of the waste management unit. Designing a surface-water management system requires a knowledge of local precipitation patterns, surrounding topographic features, and geologic conditions. After a unit is in place, consider sampling run-off to ascertain the quantity and concentration of pollutants currently being discharged. (Refer to the chapter on monitoring performance for more information.) Collecting this information may help select the most appropriate BMPs to prevent or control pollutant discharges. Figure 1 illustrates the process of identifying and selecting the most appropriate BMPs.

After assessing the potential and existing sources of storm water contamination, the

What are BMPs?

BMPs are measures used to reduce or eliminate contaminate releases to the environment. They can take the form of a process, activity, or physical structure.

Figure 1. BMP Identification and Selection Flow Chart

Assessment Phase
Develop a site map
Inventory and describe exposed materials
List significant spills and leaks
Identify areas associated with industrial activity
Test for nonstorm-water discharges
Evaluate monitoring/sampling data if appropriate
(see monitoring performance chapter)

↓

BMP Identification Phase
Operational BMPs
Source control BMPs
Erosion and sediment control BMPs
Treatment BMPs
Innovative BMPs

↓

Implementation Phase
Implement BMPs
Train employess

↓

Evaluation/Monitoring Phase
Conduct semiannual inspection/BMP evaluation
(see operating the waste management system chapter)
Conduct recordkeeping
Monitor surface water if appropriate
Review and revise plan

Adapted from U.S. EPA. 1992. *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices.* EPA832-R-92-006.

next step is to select appropriate BMPs to address these pollutant contamination sources. BMPs fall into three categories: baseline, activity-specific, and site-specific.

A. Baseline BMPs

These practices are, for the most part, inexpensive and relatively simple. They are geared toward preventing situations that could lead to surface-water contamination before they occur. Many industrial facilities already have these measures in place for product loss prevention, accident and fire prevention, worker health and safety, or compliance with other regulations. (See the chapter on operating the waste management system.) Baseline BMPs include the following measures.

Good housekeeping. A clean and orderly work environment is an effective first step toward preventing contamination of run-on and run-off. Inventory materials effectively and, if appropriate, store them safely in areas protected from precipitation and other water.

Preventive maintenance. Expand existing facility maintenance programs to include inspection, upkeep, and repair or replacement of surface-water protection systems.

Visual inspections. Conduct inspections of surface-water protection systems and waste management unit areas to discover potential problems and identify necessary changes. Areas to pay particularly close attention to include previous spill locations; material storage, handling, and transfer areas; and waste storage, treatment, and disposal areas. Promptly rectify any situations, such as leaks or spills, that could lead to surface-water contamination.

Spill prevention and response. Establish standard general operating practices for safety and spill prevention to reduce accidental releases that could contaminate run-on and run-off. Devise spill response plans to prevent any accidental releases from reaching surface water.

Training employees to operate, inspect, and maintain surface-water protection measures is itself considered a BMP, as is keeping records of installation, inspection, maintenance, and performance of surface-water protection measures. For more information on employee training and record keeping, consult the chapter on operating the waste management system.

B. Activity-Specific BMPs

After planning for baseline BMPs, consider planning for activity-specific BMPs. In the BMP manual for industrial facilities, *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices* (EPA832-R-92-006), EPA developed activity-specific BMPs for nine industrial activities, including waste management. The waste management BMPs are summarized in this section. Like baseline BMPs, these are often procedural rather than structural measures and, therefore, are often inexpensive and easy to implement.

Prevent waste leaks and dust emissions due to vehicular travel. To prevent leaks, ensure that trucks moving waste into and around a unit have baffles (if they carry liquid waste) or sealed gates, spill guards, or tarpaulin covers (if the waste is solid or semisolid). To minimize tracking dust off site where it can be picked up by storm water, wash trucks in a curbed truck wash area where wash water is captured and properly handled. For more information on these topics, consult the chapter on operating the waste management system. Please be aware that washwater from vehicle and equipment cleaning is considered to be "process wastewaters," and is not eligible for discharge under EPA's Multi-Sector General Permit for industrial storm water discharges. Such discharges would require coverage under either an individually drafted, site-specific NPDES permit, or an alternative NPDES general permit if one is available.

For land application, choose appropriate slopes. Minimize run-off by designing a site with slopes less than six percent. Moderate slopes help reduce storm-water run-off velocity, which encourages sedimentation and infiltration, and reduces erosion. Storm-water discharges from land application units are also regulated under the Multi-Sector General Permit.

C. Site-Specific BMPs

In addition to baseline and activity-specific BMPs, consider site-specific BMPs, which are more advanced measures tailored to specific pollutant sources at a particular waste management unit. These site-specific BMPs are grouped into seven areas—flow diversion, exposure minimization, sediment and erosion prevention, infiltration, mitigation, wetlands, and other prevention—for discussion below. With many of the surface-water protection techniques described in this section, it is important to design for an appropriate storm event. Generally, structures that control run-on and run-off should be designed for the discharge of a 24-hour, 25-year storm event.[3]

> **BMP Maintenance**
>
> Maintain these BMPs to ensure adequate surface-water protection. Maintenance is important because storms may damage surface-water protection systems, such as storage basin embarkments or spillways. Run-off may also cause sediments to settle in storage basins or ditches and carry floatables—tree branches, lumber, leaves, and litter—to the basin. Facilties may need to repair storm-water controls and periodically remove sediment and floatables.

[3]This discharge is the amount of water resulting from a 24-hour rainfall event of a magnitude with a 4 percent statistical likelihood of occurring in any given year (i.e, once every 25 years). Such an event may not occur in a given 25-year period, or may occur more than once during a single year.

When selecting and designing surface-water protection systems, consult state, regional, and local watershed management organizations. Some of these organizations maintain management plans devised at the overall watershed level that address storm-water control. They may be able to offer guidance in developing surface-water protection systems for optimal coordination with others in the watershed. As a general guide, once a BMP has been implemented, evaluate the effectiveness of the selected BMPs from time to time.

1. Flow Diversion Practices

These measures are used to protect surface water in two ways. First, they channel storm water away from waste management units to minimize contact of water with waste. Second, they carry polluted or potentially polluted materials to treatment facilities.

a. Storm-Water Conveyances (Channels, Gutters, Drains, and Sewers)

Storm-water conveyances, such as channels, gutters, drains, and sewers, may prevent storm-water run-on from entering a waste management unit or run-off from leaving a unit untreated. Some run-on and run-off conveyances collect storm water and route it around waste containment areas to prevent contact with the waste, which might otherwise contaminate storm water with pollutants. Other conveyances collect water that may have already come into contact with the waste management unit and carry it to a treatment plant (or possibly back to the unit for reapplication in the case of land application units). Conveyances should not mix the stream of storm water diverted around the unit with that of water that may have contacted waste. Remember, storm water that contacts waste is considered leachate and can only be discharged in accordance with an NPDES permit other than the Multi-Sector General Permit.

Conveyances can:

Direct storm-water flows around industrial areas, prevent temporary flooding, require little maintenance, and provide long-term control of storm-water flows.

Keep in mind:

Conveyances require routing through stabilized structures to minimize erosion. They also may increase flow rates, may be impractical if there are space limitations, and may not be economical.

Storm-water conveyances may be constructed of or lined with materials such as concrete, clay tile, asphalt, plastic, metal, riprap, compacted soil, and vegetation. The material used will vary depending on the use of the conveyance and the expected intensity of storm-water flow. Design storm-water conveyances with capacity to accept the estimated storm-water flow associated with the selected design storm event. Section IV below discusses methods for determining these flows.

b. Diversion Dikes

Diversion dikes, often made with compacted soil, direct run-on away from a waste management unit. Dikes usually are built uphill from a unit and work with a storm-water conveyance to divert the water from the unit. To minimize the potential for erosion, diversion dikes are often constructed to redirect run-off at a shallow slope to slow its velocity. A similar means of flow diversion is grading a site to keep storm water away from waste handling areas, instead of or in

Diversion dikes can:

Efectively limit storm-water flows over industrial site areas, be installed at any-time, be economical temporary structure when built from soil onsite, and be con-verted from temporary to permanent at any time.

Keep in mind:

Diversion dikes are not suitable for large drainage areas unless there is a gentle slope and may require maintenance after heavy rains.

addition to using diversion dikes to redirect water that would otherwise flow into these areas. In planning for the installation of dikes, consider the slope of the drainage area, the height of the dike, the size of the flow it will need to divert, and the type of con-veyance that will be used with the dike.

2. Exposure Minimization Practices

These measures, like flow diversion prac-tices, reduce contact of water with waste. They often are small structures immediately surrounding a higher risk area, while flow diversion practices may operate on the scale of an entire waste management unit.

a. Curbing and Diking

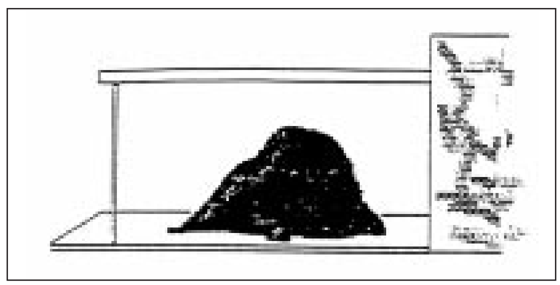
These are raised borders enclosing areas where liquid spills may occur. Such areas could include waste transfer points in land application, truck washes, and leachate man-agement areas at landfills and waste piles. The raised dikes or curbs prevent spilled liq-uids from flowing to surface waters, enabling prompt cleanup of only a small area.

b. Covering

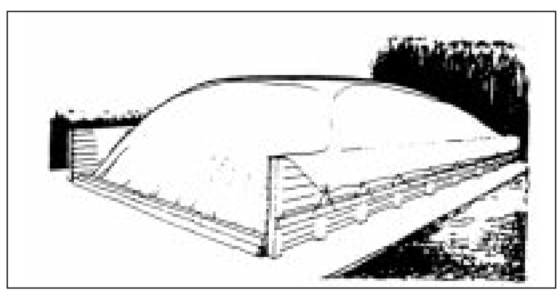
Protect surface water by erecting a roof, tarpaulin, or other permanent or temporary covering (see Figure 2) over areas where sources of surface-water contamination may be located. Such areas could include the active area of a landfill, transfer locations, and stockpiles of daily cover. Combining covering with other measures, such as curbing, can prevent precipitation from falling directly on materials and simultaneously prevent water originating elsewhere from running on to the materials.

If using temporary coverings, ensure that sufficient weight is attached to prevent wind from moving the cover, and repair or replace the cover material if holes or leaks develop.

Figure 2. Coverings



Roof, overhang, or other permanent structure



Tarp or other permanent structure

From U.S. EPA. 1992. *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices.* EPA832-R-92-006.

3. Sediment and Erosion Prevention Practices

These practices serve to limit erosion (the weathering of soil or rock particles from the ground by wind, water, or human activity) and to prevent particles that are eroded from reaching surface waters as sediment. Erosion and sedimentation can threaten aquatic life, increase treatment costs for downstream water treatment plants, and impede recreational and navigational uses of waterways. Erosion and sedimentation are of particular concern at waste management units because the sediment may be contaminated with waste constituents and because erosion may undercut or otherwise weaken waste containment structures. The following measures can help limit erosion and sedimentation.

a. Vegetation

Reduce erosion and sedimentation by ensuring that areas where water is likely to flow are vegetated. Vegetation slows erosion and sedimentation by shielding soil surfaces from rainfall impacts, improving soil's water storage capacity, holding soil in place, slowing run-off, and enabling sediment to drop out. One means of providing vegetation is to preserve natural growth. This is achieved by managing construction of the unit to minimize disturbance of surrounding plants. If it is not possible to leave all areas surrounding a unit undisturbed, preserve strips of existing vegetation as buffer zones in strategically chosen areas of the site where erosion and sediment control is most needed, such as on steep slopes and along stream banks. If it is not possible to leave sufficient buffer zones of existing vegetation, create buffer zones by planting such areas with new vegetation.

Temporary or permanent seeding of erodible areas is another means of controlling erosion and sedimentation using vegetation. Permanent seeding, often of grass, is appropriate for establishing long-term ground cover after construction and other land-disturbing activities are complete. Temporary seeding can help prevent erosion and sedimentation in areas that are exposed but will not be disturbed again for a considerable time. These areas include soil stockpiles, temporary roadbanks, and dikes. Local regulations may require temporary seeding of areas that would otherwise remain exposed greater than a certain length of time. Consult local officials to determine whether such requirements apply. Seeding may not be feasible for quickly establishing cover in arid climates or during nongrowing seasons in other climates. Sod, although more expensive, may be more tolerant of these conditions than is seed and may establish a denser grass cover more quickly. Compost can also be used effectively to establish vegetation on slopes.

Three other practices are often considered along with vegetative measures. First, streambank stabilization is the reinforcement of stream banks with stones, concrete or asphalt, logs, or gabions— structures formed from crushed rock encased in wire mesh. Stabilization is appropriate where stream flow may be increased due to construction or other unit activities and where vegetative measures are not practical. Second, mulching, compost, matting, and netting cover surfaces that are steep, arid, or otherwise unsuitable for planting. These methods also can work in conjunction with planting to secure and protect seeds. Mattings are sheets of mulch that are more stable than loose mulch chips. Netting is a mesh of jute, wood fiber, plastic, paper, or cotton that can hold mulch on the ground or stabilize soils. These measures are sometimes used with seeding to provide insulation, protect against birds, and hold seeds and soil in place. Third, chemical stabilization—also known as chemical mulch, soil binder, or soil palliative—involves spraying vinyl, asphalt, or rubber onto soil surfaces to hold the soil in place and protect against erosion. Erosion and sediment control is immediate upon spraying and does not depend on climate or season. Apply stabilizer according to manufacturer's instructions to ensure that water quality is not affected, and avoid coating a large area with a thick layer of stabilizer, which would create an impervious surface and speed run-off to downgradient areas.

b. Interceptor Dikes and Swales

Dikes, or ridges of compacted soil, and swales, excavated depressions in which water flows, work together to prevent entry of run-on into erodible areas. A dike is built across a slope upgradient of an area to be protected, such as a waste management unit, with a swale just above the dike. Water flows down the slope, accumulates in the swale, and is blocked from exiting it by the dike. The swale is graded to direct water slowly downhill across the slope to a stabilized outlet structure. Since flows are concentrated in the swale, it is important to vegetate the swale to prevent erosion of its channel and grade it so that predicted flows will not damage vegetation.

c. Pipe Slope Drains

Pipe slope drains are flexible pipes or hoses used to traverse a slope that is already damaged or at high risk of erosion. They are often used in conjunction with some means of blocking water flow on the slope, such as a dike. Water collects against the dike and is then channeled to one point along the dike where it enters the pipe, which conveys it downhill to a stabilized (usually riprap-lined) outlet area at the bottom of the slope. Ensure that pipes are of adequate size to accommodate the design storm event and are kept clear of clogs.

d. Silt Fences, Straw Bales, and Brush Barriers

Silt fences (see Figure 3) and straw bales (see Figure 4) are temporary measures designed to capture sediment that has already eroded and to reduce the velocity of storm water. Silt fences and straw bales should not be considered permanent measures. They could be used, for example, during construction of a waste management unit or on a final cover before permanent grass growth is established. Silt fences consist of geotextile fabric supported by wooden posts. These fences slow the flow of water and retain sediment as water filters through the geotextile fabric. If properly installed, straw bales perform a similar function. Straw bales should be placed end to end (with no gaps in between) in a shallow, excavated trench and staked into place. Silt fences and straw bales limit sediment entering

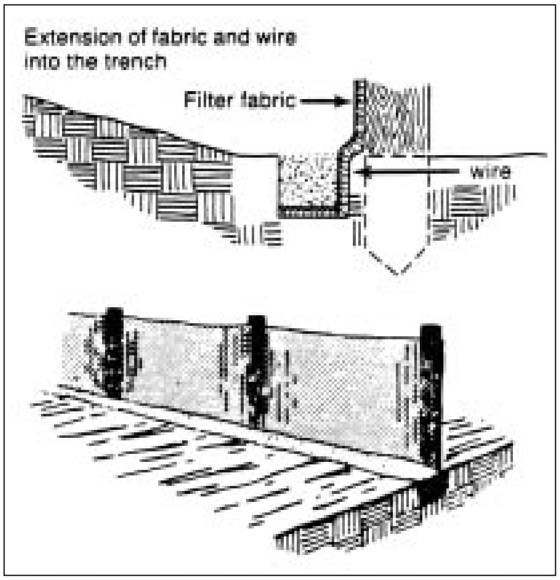
Silt fences, straw bales, and brush barriers can:

Prevent downstream damage from sediment deposits and inexpensively prevent eroded materials from reaching surface waters

Keep in mind:

These measures are not aproriate for streams or large swales and pose a risk of washouts if improperly installed.

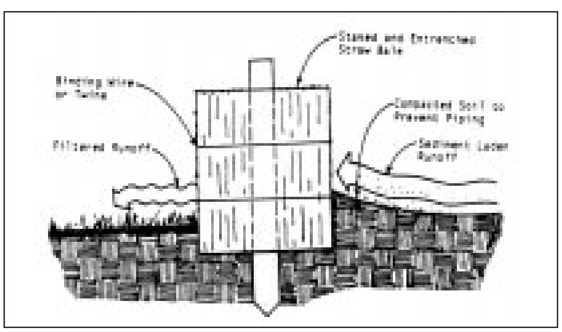
Figure 3. Silt Fence



Bottom: Perspective of silt fence. Top: Cross-section detail of base of silt fence.

From U.S. EPA. 1992. *Storm Water Management for Industrial Activitites: Developing Pollution Prevention Plans and Best Management Practices.* EPA832-R-006.

Figure 4. Straw Bale



From U.S. EPA. 1992. *Storm Water Management for Industrial Activitites: Developing Pollution Prevention Plans and Best Management Practices.* EPA832-R-006.

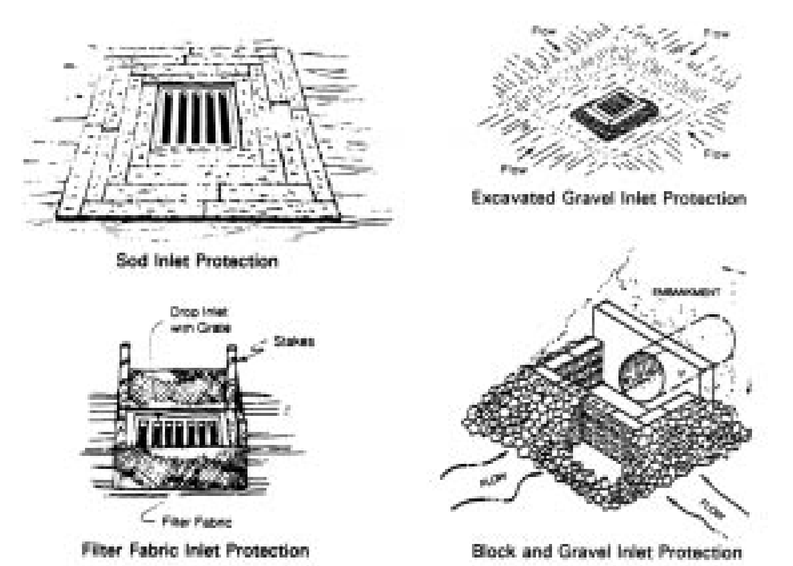
receiving waters. Both measures require frequent inspection and maintenance, including checking for channels eroded beneath the fence or bales, removing accumulated sediment, and replacing damaged or deteriorated sections.

Brush barriers work like silt fences and straw bales but are constructed of readily available materials. They consist of brush and other vegetative debris piled in a row and are often covered with filter fabric to hold them in place and increase sediment interception. Brush barriers are inexpensive due to their reuse of material that is likely available from clearing the site. New vegetation often grows in the organic material of a brush barrier, helping anchor the barrier with roots. Depending on the material used, it may be possible to leave a former brush barrier in place and allow it to biodegrade, rather than remove it.

e. Storm Drain Inlet Protection

Filtering measures placed around any inlet or drain to trap sediment are known as inlet protection (see Figure 5). These measures prevent sediment from entering inlets or drains and possibly making their way to the receiving waters into which the storm drainage system discharges. Keeping sediment out of drainage systems also serves to prevent clogging, loss of capacity, and other problems associated with siltation of drainage structures. Inlet protection methods include sod, excavated areas for settlement of sediment, straw bales or filter fence, and gravel or stone with wire mesh. These measures are appropriate for inlets draining small areas where soil will be disturbed. Some jurisdictions require installation of these measures before disturbance of more than a certain acreage of land begins. Clean accumulated sediment from inlet protection material frequently to ensure continued operation.

Figure 5. Storm Drain Inlet Protection



From U.S. EPA. 1992. *Storm Water Management for Industrial Activitites: Developing Pollution Prevention Plans and Best Management Practices.* EPA832-R-006.

f. Collection and Sedimentation Basins

A collection or sedimentation basin (see Figure 6) is an area that retains run-off long enough to allow most of the sediment to settle out and accumulate on the bottom of the basin. Since many pollutants are attached to suspended solids, some other pollutants also may settle out in the basin with the sediment. The quantity of sediment removed will depend on basin volume, inlet and outlet configuration, basin depth and shape, and retention time. Basins should be periodically dredged to remove the accumulated sediment and regularly maintained to minimize growth of aquatic plants that can reduce their effectiveness. All dredged materials, whether they are disposed of or reused, should be managed appropriately.

Basins also may present a safety hazard. Fences or other measures to prevent unwanted public access to the basins and their associated inlet and outlet structures are prudent safety precautions.

In designing collection or sedimentation basins (a form of surface impoundment), consider stormwater flow, sediment and pollutant loadings, and the characteristics of expected pollutants. In the case of certain pollutants, it may be appropriate to line the basins to protect the ground water below. Lining a basin with concrete also facilitates maintenance by allowing dredging vehicles to drive into a drained basin and remove sediment. Poor implementation of baseline and activity-specific BMPs may result in high sediment and pollutant loads, leading to unusually frequent dredging of settled materials. For this reason, when operating sedimentation basins, ensure that baseline and activity-specific BMPs are first implemented to the fullest extent practicable. Construction of these basins should be

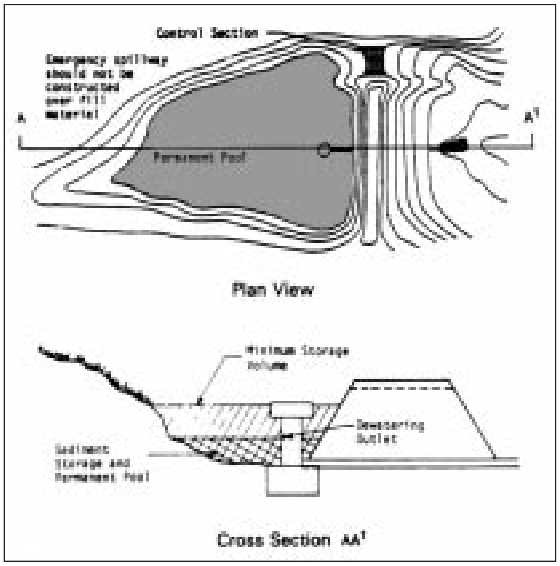
Sedimentation basins can:

Protect downstream areas against clogging or damage, and contain smaller sediment particles than sediment traps can due to their longer detention time.

Keep in mind:

Sedimentation basins are generally not suitable for large areas, require regular maintenance and cleaning, and will not remove very fine silts and clays unless used with other measures

Figure 6.
Collection and Sedimentation Basins



From U.S. EPA. 1992. *Storm Water Management for Industrial Activitites: Developing Pollution Prevention Plans and Best Management Practices.* EPA832-R-006.

supervised by a qualified engineer familiar with state, regional or watershed, and local storm-water requirements.

g. Check Dams

Small rock or log dams erected across a ditch, swale, or channel can reduce the speed of water flow in the conveyance. This reduces erosion and also allows sediment to settle out along the channel. Check dams are especially useful in steep, fast-flowing swales where vegetation cannot be established. For best results, place check dams along the swale so that the crest of each check dam is at the same elevation as the toe (lowest point) of the previous (upstream) check dam. Check dams work best in conveyances draining small areas and should be installed only in manmade conveyances. Placement of check dams in streams may require a permit and is not recommended.

h. Terraces and Benches

Terraces and benches are earthen embankments with flat tops or ridge-and-channels. Terraces and benches hold moisture and minimize sediment loadings in run-off. They may be used on land with no vegetation or where it is anticipated that erosion will be a problem. Terraces and benches reduce erosion damage by capturing surface run-off and directing it to a point where the run-off will not cause erosion or damage. For best results, this point should be a grassy waterway, vegetated area, or tiled outlet. Terraces and benches should not be constructed on sandy or rocky slopes.

What are some advantages of terraces and benches?

Terraces and benches reduce run-off speed and increase the distance of overland run-off flow. In addition, they hold moisture better than do smooth slopes and minimize sediment loading of surface run-off.

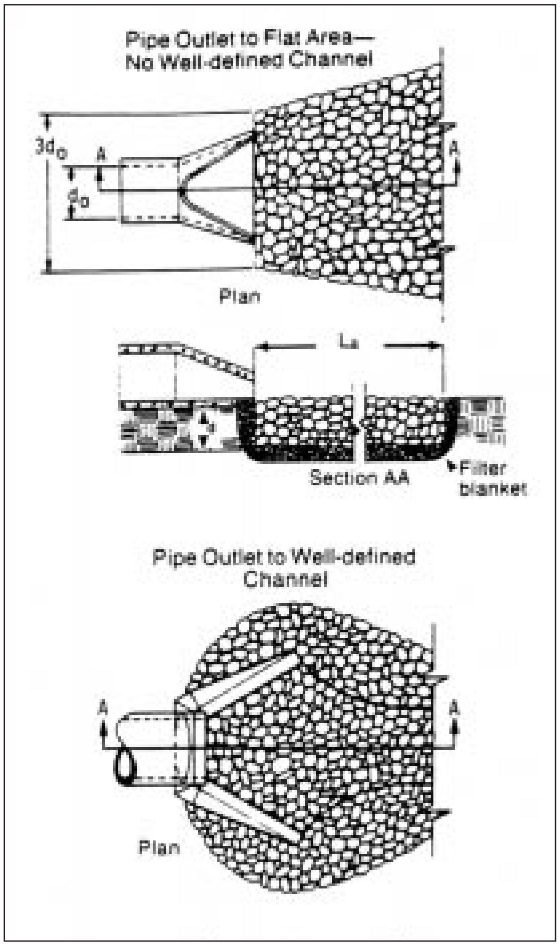
What are some disadvantages of terraces and benches?

Terraces and benches may significantly increase cut and fill costs and cause sloughing if excess water infiltrates the soil. They are also not practical for sandy, steep, or shallow soils.

i. Outlet Protection

Stone, riprap, pavement, or other stabilized surfaces placed at a storm-water conveyance outlet are known as outlet protection (see Figure 7). Outlet protection reduces the speed of concentrated storm-water flows exiting the outlet, lessening erosion and scour of

Figure 7. Outlet Protection



From U.S. EPA. 1992. *Storm Water Management for Industrial Activitites: Developing Pollution Prevention Plans and Best Management Practices.* EPA832-R-006.

channels downstream. It also removes sediment by acting as a filter medium. Consider installing outlet protection wherever predicted outflow velocities may cause erosion.

4. Infiltration Practices

These measures encourage quick infiltration of storm-water run-off by preserving or providing porous surfaces. Infiltration not only reduces run-off velocity but also provides some treatment of run-off, preserves natural stream flow, and recharges ground water. In many cases, these added functions are beneficial, but they may make infiltration practices inappropriate on unstable slopes, in cases where run-off may be contaminated, or where wells, foundations, or septic fields are nearby.

a. Vegetated Filter Strips and Grassed Swales

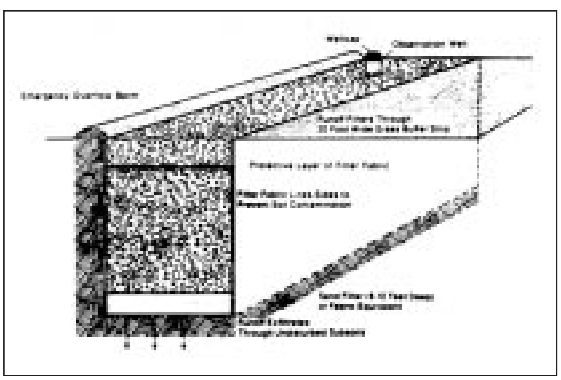
Vegetated filter strips are gently sloped areas of natural or planted vegetation. They allow water to pass over them in sheetflow (run-off that flows in a thin, even layer), infiltrate the land, and drop sediment. Vegetated filter strips are appropriate where soils are well drained and the ground-water table is well below the surface. They will not work well on slopes of 15 percent or more due to high run-off velocity. Strips should be at least 20 feet wide and 50 to 75 feet long in general, and longer on steeper slopes. If possible, plan to leave existing natural vegetation in place as filter strips, rather than planting new vegetation, which will not function as well until it becomes established.

Grassed swales function similarly to nonvegetated swales (see Sediment and Erosion Control Practices above) except that grass planted along the swale bottom and sides will slow water flow and filter out sediment. Permeable soil in which the swale is cut encourages reduction of water volume through infiltration. Check dams (see Sediment and Erosion Control Practices above) are sometimes provided in grassed swales to further slow run-off velocity, increasing the rate of infiltration. To optimize swale performance, use a soil which is permeable but not excessively so; very sandy soils may not hold vegetation well or may not form a stable channel structure. Additionally, grade the swale to a very gentle slope to maximize infiltration.

b. Infiltration Trenches

An infiltration trench (see Figure 8) is a long, narrow excavation ranging from 3 to 12 feet deep. It is filled with stone to allow for temporary storage of storm water in the open spaces between the stones. The water eventually infiltrates surrounding soil or is collected by perforated pipes in the bottom of the trench and conveyed to an outflow point. Such trenches can remove fine sediments and soluble pollutants. They should not be built in relatively impervious soils, such as clay, that would prevent water from draining from the bottom of the trench; less than 3 feet above the water table; in soil that is subject to deep frost penetration; or at the foot of slopes steeper than 5 percent. Infiltration trenches should not be used to handle contaminated run-off. Run-off can be pretreated using a grass buffer/filter strip or treated in the trench with filter fabric.

Figure 8. Infiltration Trench



From U.S. EPA. 1992. Storm Water Management for Industrial Activitites: Developing Pollution Prevention Plans and Best Management Practices. EPA832-R-006.

5. Other Prevention Practices

Prevention of surface-water contamination can be accomplished by means other than flow diversion, exposure minimization, sediment and erosion control, or infiltration. Many of these practices are simple and inexpensive to implement.

a. Preventive Monitoring

This includes automatic monitoring and control systems, monitoring of operations by unit personnel, and testing of equipment. These processes ensure that equipment functions as designed and is in good repair, so that spills and leaks, which could contaminate surface water, are minimized and do not go undetected when they do occur. Some automatic monitoring equipment, such as pressure gauges coupled with pressure relief devices, can correct problems without human intervention, preventing leaks or spills that could contaminate surface water if allowed to occur. Other monitoring equipment may provide early warning of problems so that personnel can intervene before leaks or spills occur. Systems that could contaminate surface water if they failed and that could benefit from automatic monitoring or early warning devices include leachate pumping and treatment systems, liquid waste distribution and storage systems at land application units, and contaminated run-off conveyances.

b. Dust Control

In addition to being an airborne pollutant itself, dust can be deposited as sediment in run-off, threatening downstream surface waters. Several methods of dust control are available to prevent this. These include irrigation, chemical treatments, minimization of exposed soil areas, wind breaks, tillage, and sweeping. For further information on dust control, consult the chapter on operating the waste management system.

c. Vehicle Washing

Materials that accumulate on tires and other vehicle surfaces and then disperse across a facility are an important source of surface-water contamination. Vehicle washing removes materials such as dust and waste. Washing stations can be located near waste transfer areas or near the site exit. Pressurized water spray is usually sufficient to remove dust. Waste water from vehicle washing operations should be contained and handled appropriately. Discharge of such waste water requires an NPDES permit other than the Multi-Sector General Permit.

6. Mitigation Practices

These practices contain, clean up, or recover spilled, leaked, or loose material before it can reach surface water and cause contamination. Other BMPs should be considered and implemented to avoid releases, but procedures for mitigation should be devised so that unit personnel can react quickly and effectively to any releases that do occur. Mitigation practices include simply sweeping or shoveling loose waste into appropriate areas of the unit, vacuuming or pumping spilled materials into appropriate treatment or handling systems, cleaning up liquid waste or leachate using sorbents such as sawdust, or applying gelling agents to prevent spilled liquid from flowing towards surface water.

a. Discharges to Wetlands

Other methods of storm-water control are available, such as discharge to constructed wetlands. These methods are less frequently used and may involve more complicated designs. The discharge of storm water into natural wetlands, or the modification of such wetlands to improve their treatment capacity, may damage a wetland ecosystem and, therefore, is subject to federal, state, and local regulations.

Constructed wetlands can:

Provide aesthetic as well as water quality benefits and areas for wildlife habitat.

Keep in mind:

This method may be subject to multiple federal, state and local regulations. In addition, constructed wetlands may not be feasible if land is not available and may not be effective until time has been allowed for substantial plant growth.

Constructed wetlands provide an alternative to natural wetlands. In this method, a specially designed pond or basin, which is lined in some cases, is stocked with wetland plants that can manage pollutants through biological uptake, microbial action, and other mechanisms, as well as sedimentation. This process often results in better pollutant removal than would be expected from sedimentation alone. When designing constructed wetlands, consider that maintenance may include dredging, similar to that required for sedimentation basins; provisions for a dry-weather flow to maintain the wetlands; measures to limit mosquito breeding; structures to prevent escape of floating wetland plants (such as water hyacinths) into downstream areas where they are undesirable; and a program of harvesting and replacing plants.

IV. Methods of Calculating Run-on and Run-off Rates

The design and operation of surface-water protection systems will be driven by storm-water flow. Calculate run-on and run-off flows for the chosen design storm event in order to properly size controls and minimize storm-water impacts. Controls based on too small a design storm event, or sized without calculating flows, may release contaminated storm water. Similarly, systems can also be designed for too large a flow, resulting in unnecessary controls and excessive costs.

The usual approach for sizing surface-water protection systems relies on the use of standardized "design storms." A design storm is, in theory, representative of many recorded storms and reflects the intensity, volume, and duration of a storm predicted to recur once in a given number of years. In general, surface-water protection structures should be designed to handle the discharge from a 24-hour, 25-year storm event—a rainfall event of 24 hours duration and of such a magnitude that it has a 4 percent statistical likelihood of occurring in any given year.

The Hydrometeorological Design Studies Center (HDSC) at the National Weather Service has prepared *Technical Paper 40, Rainfall Frequency Atlas of the United States for Durations From 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years.* This document, published in 1961, contains rainfall intensity information for the entire United States. Another HDSC document, *NOAA Atlas 2, Precipitation Frequency Atlas of the Western United States* comes in 11 volumes, one for the 11 westernmost of the contiguous 48 states. It was published in 1973. Precipitation frequency maps for the eleven western most states are available on the Western Regional Climate Center's web page at **< www.wrcc.sage.dri.edu/pcpnfreq.html >**, and are included in Appendix IV. HDSC is currently assembling more recent data for some areas. The state or local regulatory agency may be able to provide data for the area.

Several methods are available to help calculate storm-water flows. The Rational Method (see sidebar) may be used for calculating run-off for areas of less than 200 acres. Another potentially helpful tool for estimating storm flows is the Natural Resource Conservation Service's TR-55 software.[4] TR-55 estimates run-off volume from accumulated rainfall and then applies the run-off volume to a simplified hydrograph for peak discharge total run-off estimations.

Rational Method for Calculating Storm-Water Run-off Flow

$Q = cia$

where

Q = peak flow rate (run-off), in cubic feet per second (cfs)*

c = run-off coefficient, unitless. The coefficient c is not directly calculable, so average values based on experience are used. Values of c range from 0 (all infiltration, no run-off) to 1 (all run-off, no infiltration). For example, flat lawns with sandy soil have c of 0.05 to 0.10, while concrete streets have c of 0.80 to 095.

i = average rainfall intensity, in inches per hour, for the time of concentration, t_c, which is a calculable flowtime from the most distant point in the drainage area to the point at which Q is being calculated. Once t_c is calculated and a design storm event frequency selected, i can be read from a graph such as that shown in Figure 9.

a = drainage area, in acres. The drainage area is the expanse in which all run-off flows to the point at which Q is being calculated.

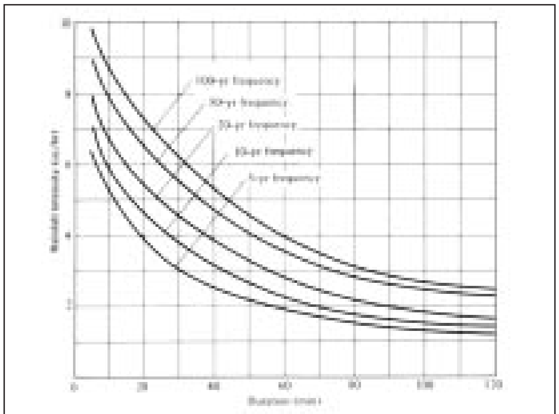
* Examining the units of i and *a* would indicate that *Q* should be in units of ac-in/hr. Since1 ac-in/hr = 1.008 cfs, however, the units are interchangeable with a negligible loss of accuracy, and units of cfs are usually desired for subsequent calculations.

[4] TR-55, Urban Hydrology for Small Watersheds Technical Release 55, presents simplified procedures to calculate storm run-off volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs. These procedures are applicable in small and especially urbanizing watersheds. TR-55 can be downloaded from NRCS at **<www.ncg.nrcs.usda.gov/tech_tools.html>**.

Computer models are available to aid in the design of run-on and run-off control (see sidebar). EPA's Storm Water Management Model (SWMM) is a comprehensive model capable of simulating the movement of precipitation and pollutants from the ground surface through pipe and channel networks, storage treatment units, and finally to receiving water bodies. Using SWMM, it may be possible to perform both single-event and continuous simulation on catchments having storm sewers and natural drainage, for prediction of flows, stages, and pollutant concentrations.

Some models, including SWMM, were developed for purposes of urban storm-water control system design, so it is necessary to ensure that their methodology is applicable to design for industrial units. As with all computer models, these should be used as part of the array of design tools, rather than as a substitute for careful consideration of the unit's design by qualified professionals.

Figure 9. Typical Intensity-Duration-Frequency Curves



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BASINS: A Powerful Tool for Managing Watersheds. A multi-purpose environmental analysis system that integrates a geographical information system (GIS), national watershed data, and state-of-the-art environmental assessment and modeling tools into one convenient package.

Storm Water Management Model (SWMM). Simulates the movement of precipitation and pollutants from the ground surface through pipe and channel networks, storage treatment units, and receiving waters.

The Source Loading and Management Model (SLAMM). Explores relationships between sources of urban run-off pollutants and run-off quality. It now includes a wide variety of source area and outfall control practices. SLAMM is strongly based on actual field observations, with minimal reliance on theoretical processes that have not been adequately documented or confirmed in the field. SLAMM is mostly used as a planning tool, to better understand sources of urban run-off pollutants and their control.

Simulation for Water Resources in Rural basins (SWRRB). Simulates hydrologic, sedimentation, and nutrient and pesticide transport in large, complex rural watersheds. It can predict the effect of management decisions on water, sediment, and pesticide yield with seasonable accuracy for ungauged rural basins throughout the United States.

Pollutant Routing Model (P-ROUTE). Estimates aqueous pollutant concentrations on a reach by reach flow basis, using 7Q10 or mean flow.

Enhanced Strem Water Quality Model (QUAL2E). Simulates the major reactions of nutrient cycles, algal production, benthic and carbonaceous demand, atmospheric reaeration and their effects on the dissolved oxygen balance. It is intended as a water quality planning tool for developing total maximum daily loads (TMDLs) and can also be used in conjunction with field sampling for identifying the magnitude and quality charactersitics of nonpoint sources

Action Items for Protecting Surface Water

Conduct the following activities when designing or operating a units surface-water protection systems.

- ❑ Comply with applicable National Pollutant Discharge Elimination System (NPDES) and state permitting requirements.

- ❑ Assess operating practices, potential pollutant sources, and surface-water flows to determine the need for and type of storm-water controls.

- ❑ Implement baseline and activity-specific best management practices (BMPs), such as good housekeeping practices and spill prevention and response plans.

- ❑ Choose a design storm event, such as the 24-hour, 25-year event, and obtain precipitation intensity data for that event to size storm-water control devices.

- ❑ Select and implement site-specific BMPs, such as diversion dikes, sedimentation basins, and outlet protection.

- ❑ Devise a system for inspecting and maintaining the chosen controls, possibly as part of the operating plan.

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